SCIENCE

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THE EARTH'S CRUST[1]

THE idea of the greater inequalities of the globe being approximately static equilibrium has been recognized for many years: it was expressed by Babbage and Herschel; it was included in Archdeacon Pratt's theory of compensation; and it was accepted by Fisher as one of the fundamental facts on which his theory of mountain structure rested. But in 1889 Captain C. E. Dutton presented the idea "in a modified form, in a new dress, and in greater detail"; he gave the idea orthodox baptism and a name, which seems to be necessary for the respectable life of any scientific theory. "For the condition of equilibrium of figure, to which gravitation tends to reduce a planetary body, irespective of whether it be homogeneous or not." Dutton[2] proposed "the name *isostasy.*" The corresponding adjective would be isostatic—the state of balance between the ups and downs on the earth.

For a long time geologists were forced to content themselves with the conclusion that the folding of strata is the result of the crust collapsing on a cooling and shrinking core; but Fisher pointed out that the amount of radial shrinking could not account even for the present great surface inequalities of the lithosphere, without regard to the enormous lateral shortening indicated by the folds in great mountain regions, some of which, like the Himalayan

[1] Concluding part of the address of the president of the Geological Section of the British Association for the Advancement of Science, Australia, 1914.

[2] Dutton, "On Some of the Greater Problems of Physical Geology," *Bull. Phil. Soc. Wash.*, XI., 53, 1889.

folds, were formed at a late date in the earth's history, folds which in date and direction have no genetic relationship to G. H. Darwin's primitive wrinkles. Then, besides the folding and plication of the crust in some areas, we have to account for the undoubted stretching which it has suffered in other places, stretching of a kind indicated by faults so common that they are generally known as normal faults. It has been estimated by Claypole that the folding of the Appalachian range resulted in a horizontal compression of the strata to a belt less than 65 per cent. of the original breadth. According to Heim the diameter of the northern zone of the central Alps is not more than half the original extension of the strata when they were laid down in horizontal sheets. De la Beche, in his memoir on Devon and Cornwall, which anticipated many problems of more than local interest, pointed out that, if the inclined and folded strata were flattened out again, they would cover far more ground than that to which they are now restricted on the geological map. Thus, according to Dutton, Fisher, and others, the mere contraction of the cooling globe is insufficient to account for our great rock-folds, especially great folds like those of the Alps and the Himalayas, which have been produced in quite late geological times. It is possible that this conclusion is in the main true; but in coming to this conclusion we must give due value to the number of patches which have been let into the old crustal envelope—masses of igneous rock, mineral veins and hydrated products which have been formed in areas of temporary stretching, and have remained as permanent additions to the crust, increasing the size and bagginess of the old coat, which, since the discovery of radium, is now regarded as much older than was formerly imagined by non-geological members of the scientific world.

The peculiar nature of rock-folds presents also an obstacle no less formidable from a qualitative point of view. If the skin were merely collapsing on its shrinking core we should expect wrinkles in all directions; yet we find great folded areas like the Himalayas stretching continuously for 1,400 miles, with signs of a persistently directed overthrust from the north; or we have folded masses like the Appalachians of a similar order of magnitude stretching from Maine to Georgia, with an unmistakable compression in a northwest to southeast direction. The simple hypothesis of a collapsing crust is thus "quantitatively insufficient," according to Dutton, though this is still doubtful, and it is "qualitatively inapplicable," which is highly probable.

In addition to the facts that rock-folds are maintained over such great distances and that later folds are sometimes found to be superimposed on older ones, geologists have to account for the conditions which permit of the gradual accumulation of enormous thicknesses of strata without corresponding rise of the surface of deposition.

On the other hand, too, in folded regions there are exposures of beds superimposed on one another with a total thickness of many miles more than the height of any known mountain, and one is driven again to conclude that uplift has proceeded *pari passu* with the removal of the load through the erosive work of atmospheric agents.

It does not necessarily follow that these two processes are the direct result of loading in one case and of relief in the other; for slow subsidence gives rise to the conditions that favor deposition and the uplifting of a range results in the increased energy of eroding streams.

Thus there was a natural desire to see if Dutton's theory agreed with the variations of gravity. If the ups and downs are bal-

anced, the apparently large mass of a mountain-range ought to be compensated by lightness of material in and below it. Dutton was aware of the fact that this was approximately true regarding the great continental plateaus and oceanic depressions; but he imagined that the balance was delicate enough to show up in a small hill-range of 3,000 to 5,000 feet.

The data required to test this theory, accumulated during the triangulation of the United States, have been made the subject of an elaborate analysis by J. F. Hayford and W. Bowie.[3] They find that, by adopting the hypothesis of isostatic compensation, the differences between the observed and computed deflections of the vertical caused by topographical inequalities are reduced to less than one tenth of the mean values which they would have if no isostatic compensation existed. According to the hypothesis adopted, the inequalities of gravity are assumed to die out at some uniform depth, called the depth of compensation, below the mean sea-level. The columns of crust material standing above this horizon vary in length according to the topography, being relatively long in highlands and relatively short under the ocean. The shorter columns are supposed to be composed of denser material, so that the product of the length of each column by its mean density would be the same for all places. It was found that, by adopting 122 kilometers as the depth of compensation, the deflection anomalies were most effectually eliminated, but there still remained unexplained residuals or local anomalies of gravity to be accounted for.

Mr. G. K. Gilbert,[4] who was one of the earliest geologists to turn to account Dutton's theory of isostasy, has recently offered a plausible theory to account for these residual discrepancies between the observed deflections and those computed on the assumption of isostatic compensation to a depth of 122 kilometers. An attempt had already been made by Hayford and Bowie to correlate the distribution of anomalies with the main features of the geological map and with local changes in load that have occurred during comparatively recent geological times. For example, they considered the possibility of an increased load in the lower Mississippi valley, where there has been in recent times a steady deposition of sediment, and therefore possibly the accumulation of mass slightly in advance of isostatic adjustment. One would expect in such a case that there would be locally shown a slight excess of gravity, but, on the contrary, there is a general prevalence of negative anomalies in this region. In the Appalachian region, on the other hand, where there has been during late geological times continuous erosion, with consequent unloading, one would expect that the gravity values would be lower, as isostatic compensation would naturally lag behind the loss of overburden; this, however, is also not the case, for over a greater part of the Appalachian region the anomalies are of the positive order. Similarly, in the north central region, where there has been since Pleistocene times a removal of a heavy ice-cap, there is still a general prevalence of positive anomalies.

These anomalies must, therefore, remain

[3] J. F. Hayford, "The Figure of the Earth and Isostasy," U. S. Coast and Geodetic Survey, Washington, 1909. "Supplementary Investigation," Washington, 1910. See also *Science*, New Series, Vol. XXXIII., p. 199, 1911. J. F. Hayford and W. Bowie, "The Effect of Topography and Isostatic Compensation upon the Intensity of Gravity," U. S. Coast and Geodetic Survey Special Publication No. 10, Washington, 1912.

[4] "Interpretation of Anomalies of Gravity," U. S. Geol. Surv. Professional Paper 85-C, 1913, p. 29.

unexplained by any of the obvious phenomena at the command of the geologist. G. K. Gilbert now suggests that, while it may be true that the product of the length of the unit column by its mean density may be the same, the density variations within the column may be such as to give rise to different effects on the pendulum. If, for instance, one considers two columns of the same size and of exactly the same weight, with, in one case, the heavy material at a high level and in the other case with the heavy material at a low level, the center of gravity of the former column, being nearer the surface, will manifest itself with a greater pull on the pendulum; these columns would be, however, in isostatic adjustment.[5]

Gilbert's hypothesis thus differs slightly from the conception put forth by Hayford and Bowie; for Gilbert assumes that there is still appreciable heterogeneity in the more deep-seated parts of the earth, while Hayford and Bowie's hypothesis assumes that in the nuclear mass density anomalies have practically disappeared, and that there is below the depth of compensation an adjustment such as would exist in a mass composed of homogeneous concentric shells.

In order to make the Indian observations comparable to those of the United States as a test of the theory of isostasy, Major H. L. Crosthwait[6] has adopted Hayford's system of computation and has applied it to 102 latitude stations and 18 longitude stations in India. He finds that the unexplained residuals in India are far more pronounced than they are in the United States, or, in other words, it would appear that isostatic conditions are much more nearly realized in America than in India.

The number of observations considered in India is still too small for the formation of a detailed map of anomalies, but the country can be divided into broad areas which show that the mean anomalies are comparable to those of the United States only over the Indian peninsula, which, being a mass of rock practically undisturbed since early geological times, may be regarded safely as having approached isostatic equilibrium. To the north of the peninsula three districts form a wide band stretching west-north-westwards from Calcutta, with mean residual anomalies of a positive kind, while to the north of this band lies the Himalayan belt, in which there is always a large negative residual.

Colonel Burrard[7] has considered the Himalayan and Sub-Himalayan anomalies in a special memoir, and comes to the conclusion that the gravity deficiency is altogether too great to be due to a simple geosynclinal depression filled with light alluvium such as we generally regard the Gangetic trough to be. He suggests that the rapid change

[5] It is interesting to note that the idea suggested by G. K. Gilbert in 1913 was partly anticipated by Major H. L. Crosthwait in 1912 (Survey of India, Professional Paper No. 13, p. 5). Major Crosthwait in discussing the similar gravity anomalies in India remarks parenthetically: "Assuming the doctrine of isostasy to hold, is it not possible that in any two columns of matter extending from the surface down to the depth of compensation there may be the same mass, and yet that the density may be very differently distributed in the two columns? These two columns, though in isostatic equilibrium, would act differently on the plumb-line owing to the unequal distribution of mass.

"The drawback to treating this subject by hard and fast mathematical formulæ is that we are introducing into a discussion of the constitution of the earth's crust a uniform method when, in reality, probably no uniformity exists."

[6] Survey of India, Professional Paper No. 13, 1912.

[7] Survey of India, Professional Paper No. 12, 1912.

in gravity values near the southern margin of the Himalayan mass can be explained only on the assumption of the existence of a deep and narrow rift in the sub-crust parallel to the general Himalayan axis of folding. A single large rift of the kind and size that Colonel Burrard postulates is a feature for which we have no exact parallel; but one must be careful not to be misled by the use of a term which, while conveying a definite mental impression to a mathematician, appears to be incongruous with our geological experience. There may be no such thing as a single large rift filled with light alluvial material, but it is possible that there may still be a series of deep-seated fissures that might afterwards become filled with mineral matter.

With this conception of a rift or a series of rifts, Colonel Burrard is led to reverse the ordinary mechanical conception of Himalayan folding. Instead now of looking upon the folds as due to an overthrust from the north, he regards the corrugations to be the result of an under-creep of the sub-crust towards the north. Thus, according to this view, the Himalaya, instead of being pushed over like a gigantic rock-wave breaking on to the Indian *Horst* is in reality being dragged away from the old peninsula, the depression between being filled up gradually by the Gangetic alluvium. So far as the purely stratigraphical features are concerned, the effect would be approximately the same whether there is a superficial overthrust of the covering strata or whether there is a deep-seated withdrawal of the basement which is well below the level of observation.

Since the Tibetan expedition of ten years ago we have been in possession of definite facts which show that to the north of the central crystalline axis of the Himalaya there lies a great basin of marine sediments forming a fairly complete record from Paleozoic to Tertiary times, representing the sediments which were laid down in the great central Eurasian ocean to which Suess gave the name *Tethys*. We have thus so far been regarding the central crystalline axis of the Himalaya as approximately coincident with the old northern coastline of Gondwanaland; but, if Colonel Burrard's ideas be correct, the coast line must have been very much further to the south before the Himalayan folding began.

Representing what the Geological Survey of India regards as the orthodox view, Mr. H. H. Hayden[8] has drawn attention to some conclusions which, from our present geological knowledge, appear to be strange and improbable in Colonel Burrard's conclusions, and he also offers alternative explanations for the admitted geodetic facts. Mr. Hayden suggests, for instance, that the depth of isostatic compensation may be quite different under the Himalayan belt from that under the regions to the south. His assumptions, however, in this respect are, as pointed out by Colonel G. P. Lenox Conyngham,[9] at variance with the whole theory of isostasy. Mr. Hayden then suggests that most of the excessive anomalies would disappear if we took into account the low specific gravity of the Sub-Himalayan sands and gravels of Upper Tertiary age as well as of the Pleistocene and recent accumulations of similar material filling the Indo-Gangetic depression. It would not be at all inconsistent with our ideas derived from geology to regard the Gangetic trough as some three or four miles deep near its northern margin, thinning out gradually towards the undisturbed mass of the Indian peninsula, and Mr. R. D. Oldham,[10]

[8] *Rec. Geol. Surv. Ind.*, Vol. XLIII., Part 2, p. 138, 1913.

[9] *Records of the Survey of India*, Vol. V., p. 1.

[10] *Proc. Roy. Soc.*, Series A, Vol. 90, p. 32, 1914.

with this view, has also calculated the effect of such a wedge of alluvial material of low specific gravity, coming to the conclusion that the rapid change in deflection, on passing from the Lower Himalaya southward towards the peninsula, can mainly be explained by the deficiency of mass in the alluvium itself.

It is obvious that, before seeking for any unusual cause for the gravity anomalies, we ought to take into account the effect of this large body of alluvium which lies along the southern foot of the range. It is, however, by no means certain that a thick mass of alluvial material, accumulated slowly and saturated with water largely charged with carbonate of lime, would have a specific gravity so appreciably lower than that of the rocks now exposed in the main mass of the Himalaya as to account for the residual anomalies. Some of the apparent deficiency in gravity is due to this body of alluvium, but it will only be after critical examination of the data and more precise computation that we shall be in a position to say if there is still room to entertain Colonel Burrard's very interesting hypothesis.

By bringing together the geological and geodetic results we notice five roughly parallel bands stretching across northern India. There is (1) a band of abnormal high gravity lying about 150 miles from the foot of the mountains, detected by the plumb-line and pendulum; (2) the great depression filled by the Gangetic alluvium; (3) the continuous band of Tertiary rock, forming the Sub-Himalaya, and separated by a great boundary overthrust from (4) the main mass of the Outer and Central Himalaya of old unfossiliferous rock, with the snow-covered crystalline peaks flanked on the north by the (5) the Tibetan basin of highly fossiliferous rocks formed in the great Eurasian Mediterranean ocean that persisted up to nearly the end of Mesozoic times.

That these leading features in North India can hardly be without genetic relationship one to another is indicated by the geological history of the area. Till nearly the end of the Mesozoic era the line of crystalline, snow-covered peaks now forming the Central Himalaya was not far from the shore-line between Gondwanaland, stretching away to the south, and Tethys, the great Eurasian ocean. Near the end of Mesozoic times there commenced the great outwelling of the Deccan Trap, the remains of which, after geological ages of erosion, still cover an area of 200,000 square miles, with a thickness in places of nearly 5,000 feet. Immediately after the outflow of this body of basic lava, greater in mass than any known eruption of the kind, the ocean flowed into Northwest India and projected an arm eastwards to a little beyond the point at which the Ganges now emerges from the hills. Then followed the folding movements that culminated in the present Himalayan range, the elevation developing first on the Bengal side, and extending rapidly to the northwest until the folds extended in a great arc for some 1,400 miles from southeast to northwest.

New streams developed on the southern face of the now rising mass, and although the arm of the sea that existed in early Tertiary times became choked with silt, the process of subsidence continued, and the gradually subsiding depression at the foot of the hills as fast as it developed became filled with silt, sand, gravel and boulders in increasing quantities as the hills became mountains and the range finally reached its present dimensions, surpassing in size all other features of the kind on the face of the globe.

Now, it is important to remember that for ages before the great outburst of Dec-

can Trap occurred there was a continual unloading of Gondwanaland, and a continual consequent overloading of the ocean bed immediately to the north; that this process went on with a gradual rise on one side and a gradual depression on the other; and that somewhere near and parallel to the boundary line the crust must have been undergoing stresses which resulted in strain, and, as I suggest, the development of those fissures that let loose the floods of Deccan Trap and brought to an end the delicate isostatic balance.

During the secular subsidence of the northern shore line of Gondwanaland, accompanied by the slow accumulation of sediment near the shore and the gradual filing away of the land above sea-level, there must have been a gradual creep of the crust in a northerly direction. Near the west end of the Himalayan arc this movement would be towards the northwest for a part of the time; at the east end the creep would be towards the north-northeast and northeast. Thus there would be a tendency from well back in Paleozoic times up to the end of the Cretaceous period for normal faults—faults of tension—to develop on the land, with a trend varying from W.S.W.-E.N.E. to W.N.W.-E.S.E. across the northern part of Gondwanaland. We know nothing of the evidence now pigeon-holed below the great mantle of Gangetic alluvium, while the records of the Himalayan region have been masked or destroyed by later foldings. But in the stratified rocks lying just south of the southern margin of the great alluvial belt we find a common tendency for faults to strike in this way across the present peninsula of India. These faults have, for instance, marked out the great belt of coalfields stretching for some 200 miles from east to west in the Damuda valley. On this, the east side of India, the fractures of tension have a general trend of W.N.W.-E.S.E. We know that these faults are later than the Permian period, but some of them certainly were not much later.

If now we go westwards across the Central Provinces and Central India and into the eastern part of the Bombay Presidency, we find records of this kind still more strikingly preserved; for where the Gondwana rocks, ranging from Permo-Carboniferous to Liassic in age, rest on the much older Vindhyan series, we find three main series of these faults. One series was developed before Permo-Carboniferous times; another traverses the lower Gondwanas, which range up to about the end of Permian times; while the third set affects the younger and Upper Gondwanas of about Rhætic or Liassic age. Although the present topography of the country follows closely the outlines of the geological formations, it is clear from the work of the Geological Survey of India that these outlines were determined in Mesozoic times, and that the movements which formed the latest series of faults were but continuations of those which manifested themselves in Paleozoic times. According to Mr. J. G. Medlicott, the field data showed "that a tendency to yield in general east and west or more clearly northeast and southwest lines existed in this great area from the remote period of the Vindhyan fault."[11] The author of the memoir and map on this area was certainly not suspicious of the ideas of which I am now unburdening my mind; on the contrary, he attempted and, with apologies, failed to reconcile his facts to views then being pushed by the weight of "authority" in Europe. This was not the last time that facts established in India were found (to use a field-geologist's term) unconformably to lie on a basement of

[11] *Mem. Geol. Surv. Ind.*, Vol. II., 1860, Part 2, p. 256.

geological orthodoxy as determined by authority in Europe. It is important to notice that the series of faults referred to in the central parts of India are not mere local dislocations, but have a general trend for more than 250 miles.

A fault must be younger, naturally, than the strata which it traverses, but how much younger can seldom be determined. Intrusive rocks of known age are thus often more useful in indicating the age of the fissures through which they have been injected, and consequently the dykes which were formed at the time of the eruption of the great Deccan Trap give another clue to the direction of stresses at this critical time, that is towards the end of the Cretaceous period, when the northerly creep had reached its maximum, just before Gondwanaland was broken up. If, now, we turn to the geological maps of the northern part of Central India, the Central Provinces, and Bengal, we find that the old Vindhyan rocks of the Narbada valley were injected with hundreds of trap-dykes which show a general W.S.W.–E.N.E. trend, and thus parallel to the normal tension faults, which we know were formed during the periods preceding the outburst of the Deccan Trap. This general trend of faults and basic dykes is indicated on many of the published geological maps of India covering the northern part of the peninsula, including Ball's maps of the Ramgarh and Bokaro coalfields[12] and of the Hutar coalfield,[13] Hughes's Rewa Gondwana basin,[14] Jones's southern coalfields of the Satpura basin,[15] and Oldham's general map of the Son valley.[16]

We see, then, that the development of fissures with a general east-west trend in the northern part of Gondwanaland culminated at the end of the Cretaceous period, when they extended down, probably, to the basic magma lying below the crust either in a molten state, or in a state that would result in fluxion on the relief of pressure. That the molten material came to the surface in a superheated and liquid condition is shown by the way in which it has spread out in horizontal sheets over such enormous areas. Throughout this great expanse of lava there are no certain signs of volcanic centers, no conical slopes around volcanic necks; and one might travel for more than 400 miles from Poona to Nagpur over sheets of lava which are still practically horizontal. There is nothing exactly like this to be seen elsewhere to-day. The nearest approach to it is among the Hawaiian calderas, where the highly mobile basic lavas also show the characters of superfusion, glowing, according to J. D. Dana,[17] with a white heat, that is, at a temperature not less than about 1,300° C.

Mellard Reade has pointed out that the earth's crust is under conditions of stress analogous to those of a bent beam, with, at a certain depth, a "level of no strain." Above this level there should be a shell of compression, and under it a thicker shell of tension. The idea has been treated mathematically by C. Davison, G. H. Darwin, O. Fisher, and M. P. Rudski, and need not be discussed at present. Professor R. A. Daly has taken advantage of this view concerning the distribution of stresses in the crust to explain the facility for the injection of dykes and batholiths from the liquid, or potentially liquid, gabbroid magma below into the shell of tension.[18] He also shows

12 *Ibid.*, Vol. VI., Part 2.

13 *Ibid.*, Vol. XV.

14 *Ibid.*, Vol. XXI., Part 3.

15 *Ibid.*, Vol. XXIV.

16 *Ibid.*, Vol. XXXI., Part 1.

17 "Characteristics of Volcanoes," 1891, p. 200.

18 R. A. Daly, "Abyssal Igneous Injection as a Causal Condition and as an Effect of Mountain-building," *Amer. Jour. Sci.*, XXII., September, 1906, p. 205.

that the injection of large bodies of basic material into the shell of tension tends on purely mechanical grounds to the formation of a depression, or geosyncline. If this be so, are we justified in assuming that the heavy band following the southern margin of the Gangetic geosyncline is a "range" of such batholiths? The idea is not entirely new; for O. Fisher made the suggestion more than twenty years ago that the abnormal gravity at Kalianpur was due to "some peculiar influence (perhaps of a volcanic neck of basalt)."[19]

Daly's suggestion, however, taken into account with the history of Gondwanaland, may explain the peculiar alignment of the heavy subterranean band, parallel to the Gangetic depression and parallel to the general trend of the peninsular tension-faults and fissures that followed the unloading of Gondwanaland and the heavy loading of the adjoining ocean bed along a band roughly parallel to the present Himalayan folds.

R. S. Woodward objected that isostasy does not seem to meet the requirements of geological continuity, for it tends rapidly towards stable equilibrium, and the crust ought therefore to reach a stage of repose early in geologic time.[20] If the process of denudation and rise, with adjoining deposition and subsidence, occurred on a solid globe, this objection might hold good. But it seems to me that the break-up of Gondwanaland and the tectonic revolutions that followed show how isostasy can defeat itself in the presence of a sub-crustal magma actually molten or ready to liquefy on local relief of pressure. It is possible that the protracted filing off of Gondwanaland brought nearer the surface what was once the local level of no-strain and its accompanying shell of tension.

The conditions existing in northern Gondwanaland before late Mesozoic times must have been similar to those in south-west Scotland before the occurrence of the Tertiary eruptions, for the crust in this region was also torn by stresses in the S.W.–N.E. direction with the formation of a remarkable series of N.W.–S.E. dykes which give the one-inch geological maps in this region a regularly striped appearance.

There is no section of the earth's surface which one can point to as being now subjected to exactly the same kind and magnitude of treatment as that to which Gondwanaland was exposed for long ages before the outburst of the Deccan Trap; but possibly the erosion of the Brazilian highlands and the deposition of the silt carried down by the Amazon, with its southern tributaries, and by the more eastern Araguay and Tocantins, may result in similar stresses which, if continued, will develop strains, and open the way for the subjacent magma to approach the surface or even to become extravasated, adding another to the small family of so-called fissure-eruptions.

The value of a generalization can be tested best by its reliability as a basis for prediction. Nothing shows up the shortcomings of our knowledge about the state of affairs below the superficial crust so effectually as our inability to make any useful predictions about earthquakes or volcanic eruptions. For many years to come in this department of science the only worker who will ever establish a claim to be called a prophet will be one in Cicero's sense—"he who guesses well."

Thomas H. Holland

[19] "Physics of the Earth's Crust," 2d ed., 1889, p. 216.

[20] "Address to the Sect. of Mathematics and Astronomy of the Amer. Assoc.," 1889, *Smithsonian Report*, 1890, p. 196.

FRATERNITIES AND SCHOLARSHIPS AT THE UNIVERSITY OF ILLINOIS

For the past five years the office of the Dean of Men of the University of Illinois has been keeping records of the scholarship averages of the chapters of national social fraternities represented in the university. For the first two years these averages were not published. In 1912 the figures were given to the *Alumni Quarterly* with the idea that their publication might be of interest to fraternity alumni. Immediately the active members of the fraternities became interested in the scholarship ranking, and the next report was published in the *Daily Illini*. Now the semi-annual publication of the averages is awaited with no little impatience by the fraternities; in fact, from the time of the semester examinations to the publication of the report, the office of the dean of men is crowded with inquiries concerning the progress of the report.

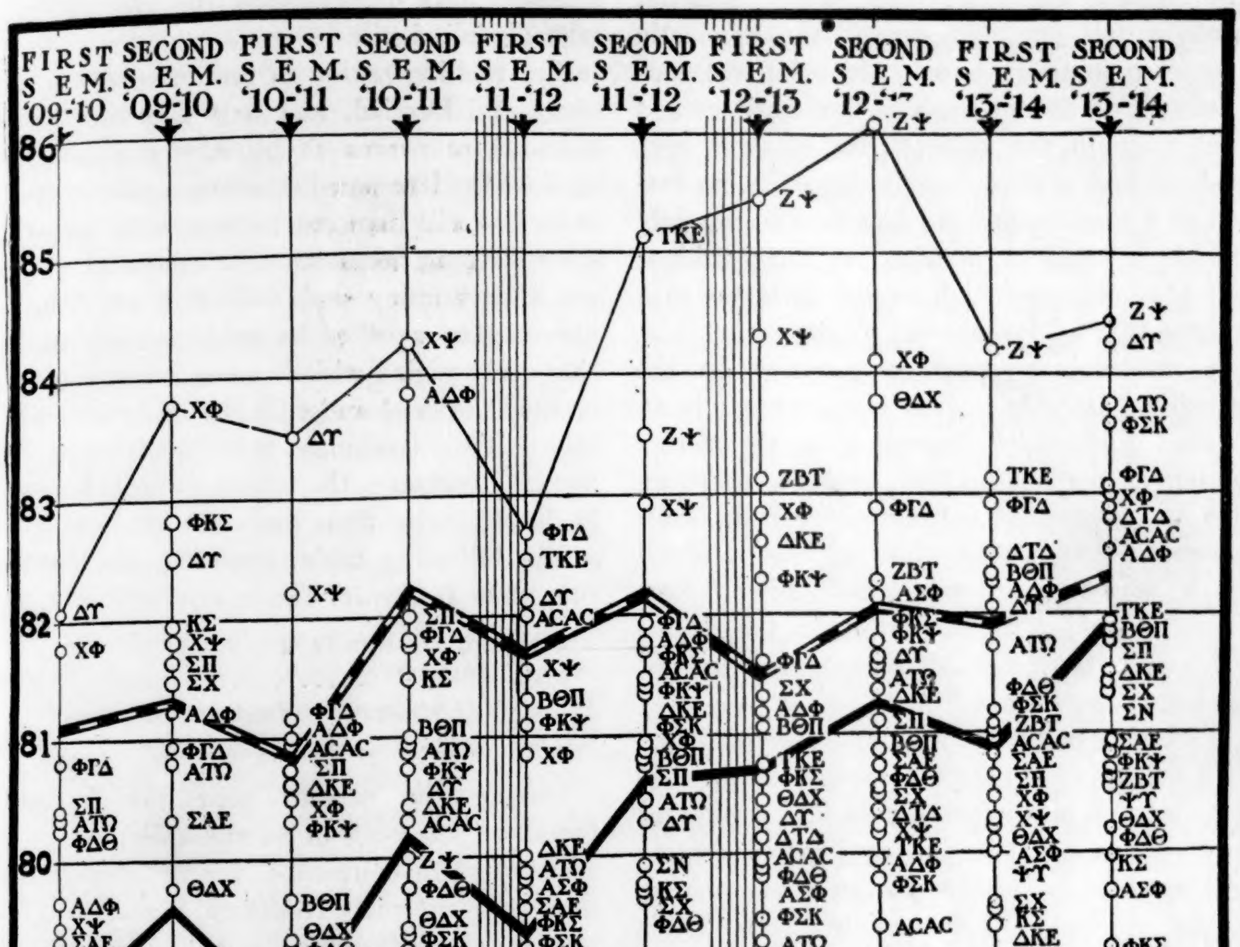
The accompanying graph has been prepared from the scholarship averages in the university for the ten semesters beginning with the first semester of 1909–1910. It shows specifically a comparison of the general fraternity average with the general university average for men; the effect upon the fraternity average of the publication of scholarship rankings and of the university regulation which provides that freshmen must obtain eleven hours of university credit before they may be initiated into a fraternity; and a study of the ups and downs of the averages of certain chapters. The graph is based upon the averages of 700 fraternity men and 2,600 fraternity and non-fraternity men.

A glance at the graph will show that in the ten semesters the fraternity average has gained upon the general university average for men, although it is still a little below it. Also, in 1909 the chapters were widely scattered up and down the scale, and in 1914 they are closely grouped around the fraternity average. This fact means undoubtedly that during the interval between these years the fraternities have intensified their attention to scholarship; the various chapters are so much alike generally that when they all enter upon the same purpose they are likely to end up closely grouped.

At two points the fraternity average jumps up quite suddenly. One point is the second semester after the introduction of the practise of publishing the averages, and the other is the semester in which was introduced the regulation controlling the initiation of freshmen. The experience of the office of dean of men, as well as the graph, records that with the publication of the averages for the first time there came a quite sudden awakening of the fraternities to scholarship matters. The office at that time was forced to provide a special system for satisfying the demands of fraternity officers for periodical reports on the progress of the members.

The reasons why the fraternities reacted so strongly to this stimulus for higher averages are various. The chapters at the bottom have undoubtedly been literally shamed into trying to raise their rating. A member of one of the chapters near the bottom when the first report was published said to me, "For years we have listened to lectures on scholarship from national officers and alumni, but nothing ever waked us up like that report. Why, everywhere we went we were 'kidded' and laughed at until, at last, in sheer desperation we took to studying." The fraternities near the top have been spurred on, undoubtedly, by the very natural desire to be first. But the great majority of the chapters are in little danger of being last and in only a small probability of being first. These middle-rank chapters, however, show fully as much concern over holding their position or improving it as do the chapters at the top and the bottom.

The reasonable explanation is, I think, that the acknowledged rivalry which has long existed in certain groups of fraternities has come to include scholarship. The fraternities may not have welcomed scholarship as a standard of comparison, but since the condition has been forced on them they are making the most of it. A member of one chapter said to me recently, "As soon as these averages are published the so-and-so chapter send in to their national officers both their average and ours." These two fraternities are strong rivals nationally. Another man said, in speaking of a freshman rushee from a small town,


FIRST SEM. '09-'10
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average for all men students
fraternity average

"He didn't know a thing about national standing, but he knew exactly the scholastic reputation of every bunch which he was considering." I do not suppose that good or bad scholarship in the abstract, unless it is very good or bad, enters largely into the reputation of a chapter, but the fact that in the only definite scheme of ranking we have this or that chapter ranks high or low is taken as a presumption of its general merit.

A rather interesting commentary on the prevailing attitude toward low averages is an ironical line which appeared in the funny column of the *Daily Illini*, apropos of the return in the second semester of certain well-known fraternity men who had been dropped out a semester for poor scholarship: "Now listen to the joyous celebration in the fraternities upon the return of some exiled flunker, batting average 52.08."

Beginning with the first semester of 1912–1913 the university at the request of the fraternities put into effect a rule providing that no freshman could be initiated into a fraternity until he had earned eleven hours of university credits. The immediate effect of this rule, as shown by the graph, was to give the general fraternity average a gain of one point over the general university average. (The actual gain of the fraternity average over the non-fraternity average was more, for the general university average includes the fraternity average.)

The direct benefit of this rule is, of course, upon the freshmen. The effect, however, has been felt by the fraternities all through, due, perhaps, to the additional emphasis placed upon scholarship in fraternity welfare, and especially upon the need which the fraternities have found to make conditions for study as favorable as possible for the freshmen. The flunking freshman has long been the "gold brick" which every fraternity might buy unwittingly. The erratic record of Kappa Sigma in 1909 and 1910, as shown by the graph, as well as the record of Sigma Nu in 1910–1911, is explained by the coming in and the going out of the freshman flunker. In these cases the average for the first semester is very low; in the second semester, after the freshman flunkers have dropped out, the average unexpectedly climbs.

The rushing season at the university is very short and hurried, and only the most exceptional care serves to guard the fraternities against the irresponsible and purposeless freshman who will turn out to be a loafer unless he finds a strong necessity to be otherwise. There are always many such freshmen who must in one way or another be held to study during that early period which comes before they have learned the need and value of study for study's sake. This freshman rule furnishes to fraternity freshmen the necessity and incentive to do otherwise than loaf.

The following table shows the effect of this rule upon fraternity freshmen:

Average of fraternity freshmen 1st semester, 1910–11	80.57
Average of fraternity freshmen 1st semester, 1913–14	82.29

During the present year the fraternity freshman has been in an enviable place so far as grades are concerned, for he ranks higher than non-fraternity freshmen, higher than fraternity upperclassmen, and higher than the general university average for men, as follows:

Average of fraternity freshmen 1st semester 1913–14	82.29
Average of non-fraternity freshmen 1st semester 1913–14	81.19
Average of fraternity upperclassmen 1st semester 1913–14	80.32
General University average for men 1st semester 1913–14	81.95

The ambition of the freshman to pass eleven hours so that he may be initiated is, of course, not alone responsible for this high average of fraternity freshmen. It is to the interest of the chapter and its reputation to initiate all of its pledges; and so most of the chapters have strict rules for the conduct of the freshmen during study hours and in other ways urge them to study. I think, however, that the prospect of initiation at the end of the first semester furnishes a stronger stimulus than would the prospect of initiation at the end of a year's work. One is led to the conclusion that if the upperclassmen were as closely supervised as

the freshmen are the fraternity average would probably creep up a notch or two farther. But as it is, the gain for the upperclassman is considerable, for a good start in the freshman year is likely to stand him in good stead for the three years thereafter. For this reason the fraternity average ought to show the effect of the introduction of this rule by a rise for the next two years, or during the period while the first two classes to enter under the rule are becoming juniors and seniors.

An interesting sidelight on the new state of affairs is the fact that at the end of the first semester of 1913–1914 five freshmen were released from their pledges to fraternities mainly because they had turned out to be hopelessly poor students.

The gain shown in the fraternity average as a result of the working of these two factors is gratifying. It is, however, perhaps too much to expect that the gap between the two averages will be closed up entirely. The normal position in most universities for the fraternity average is slightly below the general average. The explanation usually given for this condition is that the fraternities harbor the lowest average men in the university, and are thereby handicapped. Even the average fraternity men will advance this explanation. The following table, based on grades made in the first semester of 1913–1914, however, seems to indicate that such explanation is not the true one:

TABLE TO SHOW A COMPARISON OF GRADES WITHIN SPECIFIED LIMITS

	Non-fraternity Averages, Per Cent.	Fraternity Averages, Per Cent.
90–100	9	7
80– 90	58	54
70– 80	27	34
0– 70	6	5

This comparison shows that although there is a larger percentage of non-fraternity averages above 90 than fraternity averages, there is also a slightly larger percentage below passing. Apparently, then, the high and low average men are not responsible for the difference in the general averages. The middle average men seem to have the responsibility instead. Fraternity men seem more likely to be content with grades between 70 and 80 than do non-fraternity men.

It is perhaps true that in certain chapters two or three very low men are to blame for dragging down the chapter's average, but it would seem to be true that the general fraternity average is dragged down by the men who could do 85 per cent. work, but are content to do 80 per cent. or 75 per cent. work. Fraternity men are more generally represented in outside activities than non-fraternity men and it is barely possible that this fact explains their lower average. But it has been the experience of this office that the men who are active within reasonable limits in outside activities are usually pretty good students. The loafer in the classroom is usually a loafer outside. Another explanation, which I think is somewhere near the true one, is that among fraternity men the desire for high grades usually gives way to a feeling of satisfaction with passing grades. Other rewards, not open to non-fraternity men, come to take the place of the delight in high grade work which very often is the most satisfying delight of the non-fraternity man's college life.

A vast amount of chapter history is involved in the record of the ups and downs of the various averages. Chapter conditions will almost always account for the variations from year to year. Any sudden rise or fall in any chapter's record can usually be accounted for by the character of the men who were in control in the chapter at the time. For instance the sudden decline of Delta Upsilon in 1912 can be explained by an examination of the upperclassmen at that time. The quite phenomenal rise and fall of Theta Delta Chi in 1913 is explained by the coming and going of a particularly forceful man in the chapter during the year. In most cases high averages or low averages are not dependent so much upon the presence in the chapter of a number of exceptionally high or low grade men as upon the presence or absence of a masterful leader.

The curve of the average of Zeta Psi is interesting. For five semesters it is very

low; then in one semester it takes a sudden rise, and in the next semester assumes the top place, where it remains for a quite long period. The impetus to scholarship in this chapter was furnished by the planning and activity of one man during the years 1910–1911 and 1911–1912. He worked out an efficient system for improving the scholarship of the active members of the chapters and insisted upon a careful selection of freshmen pledges. He was a determined, energetic type of man and completely and thoroughly ruled his chapter. The impetus which he had given the chapter when he graduated in 1912 enabled it to hold a high position for the four semesters succeeding. He successfully solved one of the two problems of fraternity scholarship, the problem of bringing up the average from a very low to a high place.

The other problem, that of holding the average to a high standard, seems to have been successfully solved by Phi Gamma Delta. During the ten semesters this chapter has held to a consistently high average, always holding one of the first seven places among the fraternities. In this case chapter traditions have played an important part. The reputation of the Phi Gams as good students was generally known; both faculty and students expected any and every member of the chapter to be a "shark." Working with this tradition it was not especially difficult for the strong upperclassmen to start the freshmen and sophomores on the high road. Only occasionally was hard driving necessary; the most effective factor was the good-natured, "everybody-get-into-the-game" attitude which all of the members seemed to have. This chapter has usually had one or two of their faculty members living in the house with the active members.

The sudden rise of Delta Tau Delta in 1913–1914, after this chapter had trailed most of the others for many semesters, was the result of cyclonic, plunging campaign, in which national officers, faculty members, alumni, as well as every active member, had an energetic part. A dean in the faculty, coming upon the scene at a ripe moment, entered into the spirit of the fight and lent his wise advice, a junior was appointed to be a sort of bookkeeper, whose duty it was to keep account of all of the absences taken by the members and to record all of the scholarship reports forwarded; and a senior, a forceful, impulsive football player, forced the fighting. The interesting fact is that this high rank was attained by almost exactly the same type of men who for years had been holding the average down. An alumnus of the chapter stated to me that the reason for their improvement was that the chapter was lucky in getting rid of its flunkers, but I was able to point out to him in the present chapter men who under the old conditions would have become the laziest of flunkers, filling in the places left by the outgoing loafers. The improvement in scholarship in this chapter was not primarily due to any careful selection of members; it was due almost entirely to a change of conditions and management within the chapter. I think the experience of Delta Tau Delta offers the most helpful suggestions to chapter officers who have an ambition to seek higher standards of scholarship.

Cyclonic campaigns of this kind, however, solve only one of the problems to be met by fraternity officers; it is even more difficult to keep the average consistently high than it is to raise it for a semester or two. The graph will show that many of the local chapters do their work by spurts, apparently lacking the ability to keep to any consistent high average. This is so certain that it is not especially difficult to read the signs in any specified chapter and predict that it will go up or down at the next change.

From my observations of the experience of fraternities in matters of scholarship I have concluded that the one factor which stands out above others as being valuable and important is chapter management. A brief comparison of four fraternities, Phi Gamma Delta, Alpha Tau Omega, Sigma Chi and Delta Tau Delta, points to this conclusion rather clearly. These four chapters have been in existence in the university longer than most of the others, and they are remarkably alike in many respects. The chapter living conditions are much the same; each owns a comfortable house of about the same valuation; the expenses of the mem-

bers are very likely about the same in each case. Their faculty and alumni connections are similar; their college activity has been about equal. Their members are drawn from about the same localities, that is, the majority of their members come from down state communities. If the freshmen pledged to these four chapters were lined up it would be highly difficult to point out to which chapter the different men were pledged. But in matters of scholarship there have been many big differences during the ten semesters. The reason for these differences is without doubt in the difference in chapter management. Only in this way could one explain why freshmen so much alike on entering should make up chapters so different in scholarship.

A member of Sigma Chi contends that their greatest handicap has been in the weakness of the junior and senior classes year in and year out. A comparison of these four chapters on this point shows the following results:

	Number Initiated in Ten Semesters	Number Graduated in Ten Semesters
Phi Gamma Delta ...	53	32
Alpha Tau Omega ...	55	29
Sigma Chi	59	20
Delta Tau Delta	61	16

In a chapter where the upper classes are weak the work is doubled; more freshmen must be initiated and trained to fill up the gaps, and at the same time there are fewer upperclassmen available for developing the underclassmen and for furnishing efficient leadership. Then, too, the presence around the house of a number of men who expect to drop out at the end of the semester without trying to complete their courses is very demoralizing upon the work of all other members of the chapter. I have no doubt that many chapters could strengthen themselves very greatly by building up a tradition that the members of the chapter should feel an obligation to stay in college until graduation.

Another conclusion that must inevitably be drawn is that the fraternity upperclassmen are open to a charge that fraternity life engenders in the members a spirit of contentment with a grade of work somewhat lower than that of which the men are capable. The freshmen seem to be holding up their end pretty well; but the upperclassmen fail to live up to the promises of the freshmen year. This charge is really serious, and the fraternities will have to meet it sooner or later. State universities are too expensively equipped to allow any of the students to do less than their best without damaging the interests of the citizens of the state. These universities, too, are so peculiarly prepared to give a kind of training that the students may get nowhere else that fraternity men may not say that they are justified in sacrificing a part of the benefit of this training in order to get other kinds of training which, in most cases, can be obtained elsewhere. By bringing their average up to that of the general university average for men the fraternities may show that they are not guilty of the charge that they tend to develop a happy mediocrity in their members toward matters of scholarship.

Arthur Ray Warnock
University of Illinois

THEODORE NICHOLAS GILL

Many scientific associates and friends of Dr. Theodore Nicholas Gill, who died in Washington City at noon on September 25, 1914, met on the following day at the U. S. National Museum to do honor to the memory of their deceased colleague. Among those who spoke were Dr. Richard Rathbun, Acting Secretary of the Smithsonian Institution, Mr. Leonhard Stejneger, Dr. L. O. Howard, Dr. Paul Bartsch, Dr. Frank Baker, and Mr. Paul Brockett of the Museum staff, as well as Dr. Hugh M. Smith, Commissioner of Fisheries. A tribute expressing the sorrow attendant on his death and the great loss to science in general and the Smithsonian Institution and National Museum in particular was adopted at the meeting.

Dr. Theodore Gill, as he was best known, was the son of James Darrell and Elizabeth Vosburgh Gill, and was born in New York City on March 21, 1837. His early education

was received in private schools and from special tutors, and then he studied law, but was never admitted to the bar. As he grew to manhood he developed an interest in natural science and became especially interested in fishes, frequently visiting the markets along the river fronts in New York for the purpose of examining the uncommon varieties that were received there. During the winter of 1857–58 he visited Barbados, Trinidad and other West Indian Islands for Mr. D. Jackson Stewart, for whom he collected shells and various specimens of natural history. The results of his explorations were worked up mainly in the library of Mr. J. Carson Brevoort, and published in the *Annals* of the New York Lyceum of Natural History and in the *Proceedings* of the Philadelphia Academy of Natural Sciences. It was in this library (the best of its kind in the United States at that time) of this patron of science that he laid the foundations for that great knowledge of books and authorities which, combined with a splendid memory, served him so well in his after years. In 1859 he visited Newfoundland and studied its fauna, and in 1860 prepared a report on the fishes of the northern boundary for the State Department of the United States.

In 1861 he came to Washington and was given the teaching of zoology at Columbian, now George Washington, University, with which institution he remained connected until his death, although subsequent to 1910 he was emeritus professor of zoology. For much of the time during this long period he met his classes regularly, considering it a privilege to contribute his services to the university without compensation. Even after his retirement he continued his active interest in the department which he had organized and freely contributed aid and advice on all matters, devoting special attention, however, to the post-graduate work.

Almost immediately after settling in Washington, Gill came under the influence of Professor Spencer F. Baird, who was quick to appreciate his ability, and who found congenial work for him in the library of the Smithsonian Institution, of which he had charge from 1862 until 1866. When the library was transferred to the National collections in the Capitol he continued in that service until 1874 and was for a time assistant librarian of the Library of Congress. He then severed his connection with the library and thereafter devoted his attention almost exclusively to studies in natural history, working largely in the libraries of the Smithsonian Institution and the U. S. National Museum, holding the honorable appointment of associate in zoology on the scientific staff of the museum subsequent to 1894.

His activity as a zoologist was unceasing and his contribution to science included over five hundred separate papers, the greatest number of which have been on ichthyology. Of these many appear in the *Proceedings* of the Philadelphia Academy of Natural Sciences, but since 1878 the *Proceedings* of the U. S. National Museum have been his favorite medium of publication. His work was chiefly on systematic ichthyology, especially in the arrangement of fishes in classes, orders and families, yielding a more natural and restricted distribution of genera which is now universally accepted in the United States, and largely so in Europe. While no monumental work is left to us from his pen, nevertheless in nearly every zoological work his name will be found in connection with the descriptions, nomenclature, or classification of the specimens under discussion. Among the more important monographs prepared by him are the following: "Synopsis of Fresh-water Fishes" (1861); "Arrangement of the Families of Mollusks" (1871); "Arrangement of the Families of Mammals" (1872); "Arrangement of the Families of Fishes" (1872); "Catalogue of the Fishes of the East Coast of North America" (1861–73); "Principles of Zoogeography" (1884); "Scientific and Popular Views of Nature Contrasted;" "Account of Progress in Zoology" (1879–84); "Parental Care among Fresh-water Fishes" (1906); "Contributions to the Life-histories of Fishes" (1909). He wrote most of the volume on fishes and much of that on mammals in the "Standard Natural History" and was the author of numerous addresses and reviews that appeared in *Nature*, SCIENCE and other scien-

tific journals. The zoological portion of Johnson's Universal Cyclopædia and the zoological text of the Century and Standard Dictionaries were also prepared by him.

George Washington University recognized his splendid services so freely given to that institution by the conferment of the honorary degrees of A.M. in 1865; M.D. in 1866; Ph.D. in 1870, and finally in 1895 bestowing upon him its highest doctorate, that of laws. His many contributions to science were gladly recognized by honorary elections to more than seventy-five scientific societies. In the United States he was a member of the American Academy of Arts and Sciences, the American Philosophical Society, and the National Academy of Sciences. To the last of these he was elected in 1873, and at the time of his death his length of membership was exceeded by only five other members. He represented the academy at the International Zoological Congress in 1898 and was its delegate and that of the Smithsonian Institution at the 450th anniversary of the founding of the University of Glasgow in 1901. In 1868 he was elected to the American Association for the Advancement of Science, and in 1897 succeeded to the presidency of that organization on the death of his friend and colleague, Edward D. Cope.

It has been said that literature and science are not two things, but rather two aspects of the same thing—they both deal with knowledge, but the recorder of literature, the librarian, deals with knowledge in its secondary form, conclusions, which he files and reissues from time to time, while the scientist perhaps comes happily closer to nature itself through his personal investigations, the results of which he turns over to the recorder. Dr. Gill, it may be said, therefore possessed a remarkable dual ability, being both a librarian and a scientist, and, ably combining his talents, he made researches, recorded them and was able whenever called upon to present the results.

Having thus two distinct specialties, it may be readily understood that Dr. Gill, unlike many of our leading scholars, was not narrowed by a sole point of view, but possessed an exceptionally broad and generous mind, which he readily lent to divers purposes for the advancement and diffusion of scientific learning.

To establish a touch of fellowship and fraternalism among the men of the District of Columbia who had common interests in science, literature and the fine arts, he rendered much assistance during the organization of Washington's unique club, The Cosmos, and was enrolled as one of the ten founders who incorporated December 13, 1878. As a token of the esteem and affection with which he was held by the many members thereof, he was given a banquet by more than a hundred members of the club, on the occasion of his 75th birthday, and the 56th year of his published contributions to knowledge. This dinner was held on December 13, 1912, and was made the occasion for many valuable testimonials by some of the most learned scientific investigators and writers as well as numerous intimate friends, to his long and faithful services to science and literature.

As mentioned above, Dr. Gill did not incorporate his matchless store of knowledge in ponderous volumes of monumental dimensions, but as one of the speakers at the memorial meeting happily put it: "If you ask for his monument look around" in the minds and hearts of the scientific men who came into contact with him. To them he was an inexhaustible fountain both of inspiration and of information. Many a learned dissertation, many a brilliant combination or hypothesis, many a lucid and critical exposition, emanating from Washington biologists in almost every branch of the science, originated from discussions with Dr. Gill. They were in the habit of coming to him with their problems and their doubts and they seldom left him without receiving both ideas and information, no matter what their specialty. His mind was a wonderful combination of characteristics rarely found together in one man. A keenly critical and analytical power was paired with an unusually fine synthetic tact, and an amazing memory of details combined with a discriminating faculty of seeing essentials. He also possessed the fortunate gift of divesting himself of preconceived notions. Finally, no selfish desire for

self-aggrandizement obscured his judgment, which was guided solely by his desire for scientific honesty and truth. Small wonder that he became a progressive and a radical in systematic zoology, so much so that when he first published his classificatory arrangement of fishes and other vertebrates he was almost a generation ahead of his time. True, his ideas were taken up and carried out by his pupils, the American ichthyologists with David Starr Jordan at their head, but it is only recently that he had the satisfaction of learning that the European fish specialists have finally accepted his views, giving him unstinted praise for their originality and intrinsic worth.

SCIENTIFIC NOTES AND NEWS

M. Paul de Saint Marceaux has completed the monument which is to be dedicated in memory of Pierre Berthelot, the great French chemist, in front of the Collège de France, Paris.

On the occasion of the Australian meeting of the British Association, the University of Adelaide conferred the degree of doctor of science on Professor W. J. Sollas, Professor A. Penck, Professor T. W. Edgeworth David, Professor E. W. Brown, Sir Oliver Lodge, Professor H. Jungersen, Professor G. W. O. Howe, Dr. C. F. Juritz and Professor von Luschan.

Dr. Eugen Oberhummer, professor of geography at the University of Vienna, was appointed visiting Austrian professor to Columbia University for the academic year. Despite the war Professor Oberhummer is expected to be in residence during the second half-year. The visiting professors appointed from Russia and France, Professors Theodor Niemeyer and M. Paul Hazard, are said to have been called to military service.

Dr. Allan J. McLaughlin, of the U. S. Health Service, has been appointed health commissioner for Massachusetts.

The Quadrennial Fellowship of $1,000 of the Nantucket Maria Mitchell Association for the year June 15, 1915, to June 15, 1916, has been awarded to Miss Margaret Harwood, A.B., Radcliffe College, 1907, who has been for three years astronomical fellow of the association. Miss Harwood has elected to work at the University of California. The second fellowship of $500 has been awarded a year in advance, in order that the candidate may prepare herself for the special work undertaken by the Maria Mitchell Observatory. Miss Susan Raymond, A.B., Smith College, 1913, has received the appointment.

Dr. Johan Nordal Fischer Wille, professor of botany and director of the Botanical Garden of the University of Christiania, is visiting the botanical institutions of the United States. He is one of the foreign delegates to the celebration of the twenty-fifth anniversary of the Missouri Botanical Garden to be held at St. Louis on October 15 and 16.

The following members of the Western Reserve University medical faculty have returned from abroad: T. N. Stewart, professor of experimental medicine; J. J. R. MacLeod, professor of physiology; G. W. Todd, professor of anatomy and P. J. Hanzlik, instructor in pharmacology.

The first meeting of the new session of the Royal Geographical Society, London, will be held on November 9, when Mr. Belloc will lecture on "The Geography of the War." On November 23, Lord Bryce will deal with "The Mental Training of a Traveler," and on December 7, Miss Lowthian Bell will give an account of her recent journey in Arabia.

The death is recorded in *Nature* of George Gresswell, formerly lecturer in physical science, under the government of the Cape of Good Hope, at the Diocesan College, Rondebosch, and demonstrator of practical physiology and histology at Westminster Hospital.

A meeting of the Society for the Promotion of Industrial Education will be held at Richmond, Va., December 9–12.

We learn from the Los Angeles *Tribune* of September 29, that the collection of Mr. Henry Hemphill, recently referred to in Science, was

bequeathed to the California Academy of Sciences and is being prepared for exhibition at the Exposition by Mrs. T. S. Oldroyd, the well-known collector of California shells.

A gift of $15,000 a year for a period of five years has been made to the Egyptian Department of the Metropolitan Art Museum, by Mrs. Edward J. Tytus, as a memorial to her son, Robb de Peyster Tytus, who died last year.

The British Board of Trade has arranged for a commission consisting of representatives of the Board of Trade, the Timber Trade Federation of the United Kingdom, and the Mining Association of Great Britain, to proceed to Canada and Newfoundland in order to enquire into the possibility of opening up new sources of supplies of mining timber for use in the coal mines of Great Britain.

According to a report which has just been issued by the United States Bureau of Mines, the number of men killed in and about quarries in 1913 was 183. The number of men employed in the quarry industry was 106,278, and the death rate per 1,000 employed was 1.72, as compared with 1.88 during 1912. The number of men killed in 1912 was 213, the figures for 1913 showing a decrease of thirty deaths or 14 per cent. The figures show that the principal hazards of quarrying appear to be equally divided between explosives, falls of quarry material, and haulage. Accidents from these causes represent nearly two thirds of the fatalities. Albert H. Fay, engineer of the bureau, who compiled the statistics, makes the statement that in France the fatality rate for quarry accidents is seldom more than one in every 1,000 men employed, and in the year 1912 was even less than one. In Great Britain, for the ten years 1895 to 1904, the rate was 1.09 for every 1,000 men employed.

Minnesota far outranks all other states in the mining of iron ore, and during the last four years has contributed both in quantity and value considerably more than half the iron ore produced and marketed in the United States, according to the United States Geological Survey. In 1913 the total marketed production of iron ore in this country was 59,643,098 long tons, valued at $130,905,558, of which Minnesota contributed 36,603,331 tons, valued at $80,789,025. In 1912 Minnesota produced 34,249,813 long tons of iron ore, valued at $61,805,017. Because of its great wealth in iron ores and of their extended development, Minnesota ranks ninth among all the states in the total value of its mineral production. The value of the iron ore produced in the state represents considerably more than 90 per cent. of the total output. The value of the mineral products of Minnesota in 1913, exclusive of iron ore, was $5,025,508. These include the products of the stone quarries and the clay pits.

The United States Bureau of Mines is planning a comprehensive exhibit at the Panama-Pacific Exposition. In arranging the exhibit, the bureau has had in mind, not only the value of interesting those engaged in the various mining and metallurgical industries, but also the education of the general public to a better knowledge of the magnitude of these industries and to the efforts which are honestly being made by the miners and mine operators, with the assistance of the Bureau of Mines, looking toward a more safe conduct of mining and a more efficient utilization of the products of the mines after they are won from the earth. The bureau's exhibit is located in the Palace of Mines and Metallurgy. An automatic duplex projecting machine will continuously show lantern slides illustrative of the activities of the bureau and simultaneously give descriptions of the lantern slides. Near by will be shown the lay-out of a model hospital, including a receiving room, ward room and operating room, fully equipped for demonstrations by the United States Marine Hospital Service; also a model of a change and wash house, another welfare feature which is being installed at modern mining and metallurgical operations. A plan of an ideal mining town will be shown. First-aid demonstrations will be given frequently. An air of reality will be lent to the demonstration by the removal of apparently injured men from the exhibition mine beneath the building by hel-

met and rescue crews. A complete display of rescue apparatus and safety lamps will be given in a glass smoke-room. Tests of safety lamps will be made, showing their tendency, under unfavorable conditions, to ignite explosive gas, and also showing methods of testing for explosive gas by means of their caps. An exhibit of the physical and chemical characteristics and constituents of explosives is being arranged. Visitors going through the exhibition mine will regain the surface through the radium booth in which actual radium emanations will be shown. Surrounding this radium booth, there will be complete exhibits of the various radium ores and of radium products. The metallurgy of various products will be shown by a comprehensive exhibit. The opportunity for increased efficiency in the use of fuels will be demonstrated by a device showing the proportionate amounts of fuels which go to make up the various losses incident to consumption in comparison with that which ultimately goes to useful purposes. Typical analyses of coal from the various fields will be shown by models and samples, as will also the yield of coke and by-products obtained by various coking processes. It is expected to show smoke-preventing and smoke-producing methods of stoking by means of an ingenious motion-picture device. An officer of the bureau will give his whole attention to visitors. Copies of the bureau's publications will be available for free distribution to visitors who may be particularly interested. This exhibit, in connection with the exhibition mine immediately beneath the bureau's space, should be interesting and instructive to those engaged in the mining industry and to the general public.

Mr. W. G. Vieth has sent the *Geographical Journal* an account of a new island hitherto uncharted in the Kazan-retto group (Volcano Islands). Mr. Vieth left Yokohama in the yacht *Tilikum II.* on January 24, 1914, bound for Brisbane, Australia. It was while anchoring at Point Lloyd, Bonin Islands, that news was received that a Japanese resident on Naka-Iwojima (Sulphur Island), the middle one of the Kazan-retto group, had just arrived there reporting the phenomenon. It was at once decided to alter the course of the *Tilikum II.*, in order to investigate the matter. When the yacht cleared Point Lloyd, a Japanese man-of-war had just arrived there with orders of a like nature, but as the latter stayed a few days at Point Lloyd, Mr. Vieth's boat was the first to arrive at the scene. "At about 9 A.M. on February 14," he writes, "we sighted a cloud of thick blackish smoke rapidly shooting up from the sea in column shape. About noon we came quite close to the island, which is of circular form, about 1 mile in diameter, 600 feet high, with a crater in the center, opening to the southeast. It is 3 miles distant in northwesterly direction from San Augustino, the southernmost of the Volcano group. All these measures are calculated only, as we did not attempt a landing, the violent eruptions at short intervals, sometimes accompanied by a rumbling noise, preventing our approaching nearer than, say, one third of a mile. Plenty of pumice-stone was floating in the sea in patches. The island itself shows the same yellowish-gray color, and seems to consist in bulk of the same light material. The neighboring San Augustino is of much greater height, clothed with vegetation, and rises steeply from the sea. It is uninhabited. The new island bears no sign of vegetation as yet." It is asserted that a similar island had risen in the same spot about ten years ago, but soon disappeared again.

The European situation has called attention sharply to the dependence of this country upon Germany for its potash supply, some 12 or more million dollars' worth of which is used annually in the United States for fertilizer. Another necessary mineral fertilizer for which the United States is entirely dependent upon a foreign country is sodium nitrate, over 21 million dollars' worth of which was imported from Chile last year. Deposits of sodium and potassium nitrate are known in Utah, Nevada, California, Oregon, Montana and New Mexico and have been described in publications of the Geological Survey and Bureau of Soils, but thus far no material of this kind has been

found in sufficient quantity to promise commercial value. The latest report that has come to the Geological Survey relates to a deposit in Arizona. One important domestic source of combined nitrogen is the gas works and by-product coke ovens, which in 1912 reported a recovery of ammoniacal liquor, ammonia and ammonium sulphate valued at $9,519,268. This output of by-product ammonium sulphate increased in 10 years from 17,643,507 pounds to 99,070,777 pounds, and as it is linked with the great coking industry further increases can be expected. Another domestic supply of nitrogen compounds lies in the fixation of atmospheric nitrogen by electricity. Cheap hydroelectric development is necessary to establish this industry, which would make our large agricultural and industrial interests free from the uncertainties of the foreign supply. It is hoped that the water-power legislation now before the United States Senate may promote hydroelectric development in large units and thus utilize some of the great water powers in the West in obtaining nitrogen from the air.

UNIVERSITY AND EDUCATIONAL NEWS

Baker University, Baldwin, Kan., has completed its $500,000 endowment fund, of which the general education board of New York gave $50,000. The rest was contributed by 10,000 persons, the largest gift from any one of them being $25,000. The people of Baldwin, a town of 1,200 population, gave $45,000.

On October 14, Central College, Fayette, Mo., completed a campaign to increase the productive endowment of the college by $300,000. Of this amount the general educational board contributes $75,000. This fund increases the endowment of Central College to $500,000. The campus, buildings and equipment are valued at $300,000.

On October 9 exercises in connection with the laying of the corner stone of the new chemical laboratory at the University of Illinois were held. Addresses were given by Professor William A. Noyes, director of the chemical laboratory and by William Hoskins of Chicago. The exercises were presided over by the Hon. W. L. Abbott, president of the board of trustees and President Edmund J. James laid the corner stone. The entire laboratory when completed will be 231 feet long, 202 feet wide and will contain 164,288 square feet of usable space.

An addition is being built to the chemistry building of the University of California, costing, with its equipment, $40,000. It will provide laboratory accommodation for 250 students.

The uncompleted University Hall of Columbia University, which contains the power house, the gymnasium and the commons, was seriously injured by fire on the night of October 9.

A history of the University of Colorado is being compiled by Professor James F. Willard and his assistants. It will probably be published within a year.

The medical school of the University of Pennsylvania admits women this year for the first time to the regular course.

The registration at Harvard University, with the figures for the last year given in parentheses, is as follows: Out of course, 50; seniors (361), 425; juniors (487), 581; sophomores (741), 575; freshmen (622), 704; special (19), 12; unclassified (97), 115; totals (2,327), 2,462; Graduate School of Applied Science (114), 111; Graduate School of Arts and Sciences (426), 467; Graduate School of Business Administration (104), 142; Divinity School (45), 42; Law School (647), 668; Medical School (290), 325; Dental School (185), 190; grand totals (4,138), 4,407.

The following changes have been made in the faculty of the Case School of Applied Sciences: Professor R. H. Danforth, who has been professor of mechanical engineering at the United States Naval Academy, professor of mechanics and hydraulics; Mr. R. O. Jackson, graduate of the University of Maine and for some time engaged in practical engineering work, instructor in mechanical engineering; Mr. B. C. Boer, instructor in descrip-

tive geometry in Iowa State University, instructor in drawing and descriptive geometry; Mr. M. G. Edwards, graduate student in the University of Wisconsin, instructor in geology and mineralogy; Mr. T. D. Bains, Jr., a practical mining operator in California, instructor in mining engineering. The salaries of the full professors in Case School of Applied Science have been raised to $3,500.

Professor Perry B. Perkins has been called to the chair of mechanics at Brown University.

Dr. M. O. Tripp has been appointed professor of mathematics at Olivet College.

Dr. John B. Leathes, professor of pathological chemistry in the University of Toronto, leaves Toronto in December for Sheffield, England, where he has been appointed professor of physiology in the University of Sheffield.

Dr. A. W. Stewart, lecturer in organic chemistry in the Queen's University of Belfast, and formerly lecturer in stereochemistry at the University College, London, has been appointed lecturer in physical chemistry at the University of Glasgow, in succession to Professor Soddy, now of Aberdeen.

Dr. D. Waterston, professor of anatomy in King's College, London, has been appointed to succeed Professor J. Musgrove as Bute professor of anatomy in the University of St. Andrews.

DISCUSSION AND CORRESPONDENCE

DR. BATESON'S PRESIDENTIAL ADDRESS

To the Editor of Science: If a more extraordinary example of the inverted pyramid in reasoning than is comprised in the two Australian addresses by Bateson, lately published in Science, has ever been offered to a scientific audience I have never seen it. Offered as these were chiefly to a lay audience they are incomprehensible as coming from a man who has reached the presidency of the British Association.

We may admit the value of the Mendelian discovery in its relation to low and relatively simple organisms like plants, and also that in higher organisms Mendelian effects can sometimes be traced, but that unbridled hypothesis should be permitted to cover our colossal ignorance is not what we expect from such a source. When the observed facts flatly contradict a hypothesis a truly scientific expositor says "I can not account for it," and does not cover up (to the lay mind) his ignorance by the phrase of "an inhibiting factor." What is an "inhibiting factor?" Nobody knows. When the Mendelian law proves to fail utterly, as in the notorious case of the mulatto, the assumption of "excessive segregation" means nothing but "I do not know."

Any case can be "proved," by such methods but they are not scientific.

When a train is not on time it is doubtless due to "an inhibiting factor," but that explanation will hardly satisfy an impatient man who is anxious to be off, nor a railway manager seeking efficiency in his railway work.

If we assume the origin of life in a simple ameboid organism, without a soma, and the development of a rudimentary soma through natural selection, as a protection against the direct impact of the environment; and then the gradual complexity of the somatic envelope until it reaches its present grade in the higher vertebrates, what is the relation of the "germ-plasm" to the soma?

We may tolerate the theory of the continuity of the germ-plasm because it seems to fit the known facts. If it had never acquired a somatic envelope there would be nothing but ameboid organisms to this day. But to what does the germ-plasm as carried by the present generation of animal life owe its existence? Its potentiality of cell-division depends for continuity upon the nutrition furnished by the soma. Is it creditable that in hundreds of millions of evolving generations the constantly renewed germ-plasm should remain unmodified and that in an ameba there should exist unawakened the factors for hair, teeth, bones and hoofs? The idea seems to the writer preposterous. If the plasma has not changed its characters and potentialities since the ameboid epoch, why should there be anything now but amebas? If through the slow

modification of the soma the potentialities of the germ-plasm have been added to and modified, then the dispute as to the inheritance of acquired characters is a futile logomachy.

The original somatic envelope must have been derived from the original plasma. Why then should their mutual potentialities be denied?

WM. H. DALL

September 8, 1914

HEREDITY AND MENTAL TRAITS

TO THE EDITOR OF SCIENCE: In the admirable address of Professor William Bateson[1] surveying the bearing of modern views of heredity upon psychological and social problems, one admires particularly the staunch presentation of a consistent scheme of inherited traits and the readiness to apply them to a biological view of the social forces in whose intimate workings we have acquired so minute an interest. The same applies to the qualities of mind, of which alone I shall speak. One characteristic utterance is the following:

> I have confidence that the artistic gifts of mankind will prove to be due not to something added to the make-up of an ordinary man, but to the absence of factors which in the normal person inhibit the development of these gifts. They are almost beyond doubt to be looked upon as *releases* of powers normally suppressed. The instrument is there, but is "stopped down."

A very differently characteristic expression occurs in comment upon the opinion of Tom Paine inveighing against the notion of hereditary political institutions, which he regards as equally absurd as a "hereditary wise man" or a "hereditary mathematician."

> We on the contrary would feel it something of a puzzle if two parents, both mathematically gifted, had any children *not* mathematicians.

The point which I wish to raise interrogatively rather than critically is this: How far have the holders of such views—for there are many similar expressions in the recent literature—considered the problem of the assumptive nature of the unit of mental expression which is involved in such concepts as "artistic gift," "mathematically gifted?" Take the last of the expressions, and put the matter in extreme form: Suppose both parents to have specialized on quaternions, would one expect the children also to be quaternionists? Would it answer the biological requirement if the children showed ability in physics? in engineering? in science in general of any quantitative form? in a facility for abstract thought, say philosophical or economic? in a taste for study and an intellectual type of mind? Where shall we stop in considering that the trait in the child is of the same nature as the trait in the parents? We seemingly expect that the children of musicians will be musical and not the one a painter and the other a musician; on what is that expectation based, biologically considered? In brief it seems impossible to discuss mental heredity without coming to some understanding of its evidences and the modes of its expression. The equation is defective without a specific reference to the meaning of both sets of terms. Quite probably the definition is beset with large uncertainties; but it seems to a psychologist that the writers upon heredity, in applying their principles to mental traits, are in duty bound to bring the conception of a mental trait within the scheme of their considerations.

Similarly one asks in the same spirit of seeking information, why artistic gifts are in the nature of a *release* of powers which everybody has but few show, and why are mathematical gifts not of the same description? Is it the sensory dependence of the musical gift that places it in one category, which is a different category from that of the mathematical gift? And fundamentally is there such a thing as either? If so is there also a gift for steam-engineering? and why not? And what would have become of one of similar brain inheritance if he happened to be born before the days of steam? The reduction ad absurdum lies near at hand. The moral is simple. It enforces that the application of principles of heredity to mental traits can not go farther and go consistently until a reasonable understanding is reached of the probable nature of a unit of mental trait and of the equivalent forms of its possible expressions.

[1] SCIENCE, September 4, 1914.

The question of the degrees and distributions of heredity awaits a proper mode of recognition of the presence of the inherited traits. These are not as obvious as tallness or color in peas; they must in some reasonable way be made distinguishable and recognizable before their evidence can support the principles which they doubtless embody.

JOSEPH JASTROW

MADISON, WIS.,
September 21

QUANTITY AND RANK OF UNIVERSITY ATTENDANCE

RECENTLY published statistics on student attendance at our leading colleges are more notable because of certain necessary conclusions omitted than for inferences plainly intended to be drawn. The figures are overwhelmingly convincing when quantity alone is considered. When we attempt to evaluate university powers for administrating to the advancement of civilization—the primal purpose for which these institutions are established—naked quantity is the one factor of all which we should most wish to forget. Quality is the feature which ought to be most assiduously cultivated. It is not what goes into the mill, but what comes out of it, that counts.

In this last conspectus of attendance, for example, thirty American universities are considered. From institutions having the highest number of students, where the figures reach nearly 10,000, there is graduated precedence down to the thirtieth and last worth mentioning school. This last listed school becomes especially conspicuous because of the fact that its place is last.

The attendance table mentioned might have placed even greater emphasis on the quantity feature. Only the two hundred odd graduate students of this thirtieth and last listed institution might have been taken into account and this thirtieth school would then be made to assume the rôle of the tail-ender among 400 colleges of the land. But it is in this small body of students that lies the very essence of that quality of mental aptitude to which special attention is here directed, and which is entirely overlooked in the comparison.

Now it so happens that we have some very exact figures by which to express the quality of American intellectuality. They are far more reliable than any statistics which relate to mere numbers, because of the fact that they represent the mature and composite opinion of our most eminent scientific minds. It is well known how, by the one hundred authorities in science, there were selected the names of 1,000 men most distinguished in the several branches of knowledge; and how this list was recently published by Prof. J. McKeen Cattell.

Among the thousand American men of science who have become during their generation especially distinguished, who have maintained themselves as leading figures in advanced thought of the nation, and who have acquired something of an international reputation let us briefly trace the spell of the last and thirtieth school—the Johns Hopkins University. In the accompanying table is given the number out of the thousand of "starred" men who belong in each of the twelve principal branches of science. Then follows the number out of each group which has been directly associated with the Johns Hopkins University. In the third column are the percentages of Johns Hopkins men in each department.

Department	No.	J. H. U.	Per Cent.
Pathology	60	18	30
Chemistry	175	35	20
Astronomy	50	5	10
Zoology	150	35	23
Anthropology	20	0	0
Psychology	50	10	20
Mathematics	80	20	25
Geology	100	25	25
Physics	150	47	31
Botany	100	8	8
Physiology	40	22	55
Anatomy	25	15	60
Totals	1,000	240	

During the next generation, in spite of loud prediction to the contrary, these percentages will probably increase rather than diminish. The first generation of Hopkins men is yet in its prime. In a remarkable way it is copiously and creatively productive. Over all American competitors it has the start of 20 years. Whether in the third generation there

may be a falling off is a matter of conjecture. It depends upon several factors. The growth of the graduate school in the larger universities and in the state universities is an essential element, but not a disturbing one so long as college and university are reared side by side, and college spirit submerges and smothers university soul.

Thus is one fourth of all the master minds in American science a direct product of Johns Hopkins influence. So is 25 per cent. of all American scientific thought impelled by the mainspring of Baltimore. It is not quantity of university influx but quality of university output that is telling and worth while.

CHARLES KEYES

THE FUR SEAL INQUIRY, THE CONGRESSIONAL COMMITTEE AND THE SCIENTIST

SOME three years ago the "Committee on Expenditures in the Department of Commerce" of the House of Representatives, headed by Congressman Rothermel of Pennsylvania, undertook the investigation of the work of the Bureau of Fisheries on the administration of the fur seal fisheries, apparently with the definite purpose of discrediting, for political reasons, this branch of the government service. In February, 1909, there had been appointed an advisory board of the fur seal work, consisting of the following well-known zoologists, David Starr Jordan, C. Hart Merriam, Charles H. Townsend, Leonhard Stejneger and Frederic A. Lucas, to serve without pay in advising the government as to the best means of regulating the killing and the protection of the fur seals on the Pribilof Islands.

To discredit the work of the administration of the seal fisheries it was necessary also to discredit these men. The fact that they served without pay was of course open to suspicion to the machine type of politician, who naturally finds it difficult to conceive of any one doing any work for the government with no emolument attached thereto. Accordingly the majority of the committee proceeded to measure them according to their own standard and took up charges which had been filed against all and sundry by one Henry W. Elliott. This man Elliott, it may be mentioned, is a disgruntled ex-employee of the government who was dismissed in 1891 because he had been "found guilty of grave improprieties." For more than twenty years this man had persistently brought charges, not only against all the scientific men who opposed his propositions, but against seven secretaries of departments, besides senators and congressmen. These charges had been repeatedly disproved and their author discredited and officially branded as "a person unworthy of belief."

However, this repeated repudiation of the Elliott charges did not prevent the committee from taking them up again in the attempt to make political capital of them. In the face of all the testimony submitted at the hearings and on the unsupported evidence of the man who preferred the charges, the majority of the committee found in favor of the charges.

To their everlasting credit be it said that a minority of the members of this committee were so incensed at the findings of the majority in direct face of the evidence, that they insisted on presenting a minority report (Report 500, Pt. 2, 63rd Congress, 2d Session, Fur Seal Industry of Alaska, 22 pages, July 27, 1914, signed by Congressmen McGuire and Patton). This report is a scathing arraignment of the methods of procedure and the findings of the majority and of Elliott who brought the charges. A few excerpts may not be amiss here.

> The charges preferred by Elliott are without foundation in fact,—the same charges have been preferred by him with regularity for over 20 years to various committees of Congress and executive departments, and in each case found to have been groundless.
>
> Elliott, the author of these charges and the sole witness in support of them, is a person unworthy of belief and one who has been consistently repudiated in the past.
>
> The committee had no justification for the reopening of these hearings on the same charges.
>
> There is a total absence of evidence of any irregularities on their (the government's representatives) part.

Notwithstanding this well-known record, which demonstrated Elliott to be actuated by motives which rendered him wholly unreliable as a counselor in matters pertaining to this question, it is nevertheless the fact that this committee in 1911 took up these old Elliott charges—now repeated with renewed vehemence, but with no more basis of fact—erected Elliott in its midst as prosecuting witness and amicus curiæ, accepted his mere unsupported assertions of fraud and illegality as proof thereof, endeavored by every means in its power to substantiate them, and strove by severe cross examination to nullify as far as possible the effect of testimony of witnesses appearing in their own defense to answer charges. The hearings have covered thousands of pages of printed testimony.

The minority report recommends that the Department of Justice investigate Elliott with a view to bringing charges for the misuse of congressmen's franks by sending out under them abusive and defamatory matter to witnesses before the committee and for perjury under various heads, and that a joint committee of Congress be appointed to investigate "all proceedings in connection with the investigation as conducted by this committee."

It is interesting to note that of the original committee who presented the majority report, Congressman McDermott was compelled to resign from Congress owing to his connection with the disgraceful Mulhall disclosures, while Rothermel, the chairman of the committee, who was particularly vindictive in the prosecution, failed to secure renomination in his home district after charges had been made against him on the floor of the House for improper and illegal use of funds allotted to his committee.

The Rothermel committee sent Elliott as an investigator to the seal islands during the summer of 1913, a proceeding which the minority report brands as "nothing but a farce" on the grounds that "if the object of the committee had been the substantiation of the Elliott charges, it could not have adopted a more certain means of accomplishing this result than by sending Elliott himself." However, it seems that the committee overstepped its authority in doing this and Congress has refused to refund the expenses of the trip.

There is a verse concerning a mountain, which after great labor, brought forth a mouse. The work of the congressional committee headed by Rothermel has produced similar valuable results. The fiasco has been a very expensive one, however. It has cost the country many thousands of dollars, it has further endangered the existence of the seal herd already depleted by many years of pelagic sealing, it has caused the loss to the Bureau of Fisheries of the services of the eminent ichthyologist Dr. Barton W. Evermann, who has since become director of the museum of the California Academy of Sciences, and has inflicted needless expense, humiliation and irritation upon the scientists who formed the advisory board. As far as the scientific standing of these men is concerned, it is not necessary to remark that it will not suffer in the least on account of this political attempt to discredit them.

It should be mentioned that the Bureau of Fisheries has had no part whatever in these attacks on the scientists mentioned and that whatever changes have been made in the plan of conducting the seal work have been those prescribed by law. Whatever may have been the attitude in the past, of the Department of Commerce, under which the Bureau of Fisheries is placed, it is evidently desirous of learning the truth in regard to the work on the Pribilofs, for Secretary Redfield this past summer sent a special committee of three zoologists to the islands to investigate and report upon conditions there. At his request, one of these was nominated by the Department of Agriculture, one by the Smithsonian Institution and one by the National Academy of Sciences. While none of these men has had any previous acquaintance with work on the islands, they will at least be able to give an entirely unprejudiced report, even if they are unable to make any comparison with past conditions. The Dominion of Canada and Japan have also sent investigators to the seal islands. The report of this committee is awaited with interest.

Raymond C. Osburn
Columbia University,
September 12, 1914

SCIENTIFIC BOOKS

RECENT BOOKS ON MATHEMATICS

Memorabilia Mathematica or The Philomath's Quotation-book. By ROBERT EDOUARD MORITZ, Ph.D., Ph.N.D., Professor of Mathematics in the University of Washington. New York, The Macmillan Company. 1914. Pp. vii + 410.

Analytical Geometry of Space. By VIRGIL SNYDER, Ph.D., Professor of Mathematics at Cornell University, and C. H. SISAM, Ph.D., Assistant Professor of Mathematics at the University of Illinois. New York, Henry Holt and Company. 1914. Pp. xi + 285.

Analytic Geometry and Principles of Algebra. By ALEXANDER ZIWET, Professor of Mathematics, the University of Michigan, and LOUIS ALLEN HOPKINS, Instructor in Mathematics, the University of Michigan. New York, The Macmillan Company. 1913. Pp. viii + 369.

Higher Algebra. By HERBERT E. HAWKES, Ph.D., Professor of Mathematics in Columbia University. Boston, Ginn and Company. Pp. iv + 222.

Industrial Mathematics. By HORACE WILMAR MARSH, Head of Department of Mathematics, School of Science and Technology, Pratt Institute, with the collaboration of ANNIE GRISWOLD FORDYCE MARSH. New York, John Wiley and Sons. 1913. Pp. viii + 477.

Trigonometry. By ALFRED MONROE KENYON, Professor of Mathematics, Purdue University, and LOUIS INGOLD, Assistant Professor of Mathematics, the University of Missouri. Edited by EARL RAYMOND HEDRICK. New York, the Macmillan Company. 1913. Pp. xi + 132 + xvii + 124.

Trigonometry for Schools and Colleges. By FREDERIC ANDEREGG, A.M., Professor of Mathematics in Oberlin College, and EDWARD DRAKE ROE, JR., Ph.D., Professor of Mathematics in Syracuse University. Boston, Ginn and Company. Pp. viii + 108.

Advanced Algebra. By JOS. V. COLLINS, Ph.D., Professor of Mathematics, State Normal School, Stevens Point, Wisconsin. New York, American Book Company. 1913. Pp. x + 342.

The Algebra of Logic. By LOUIS COUTURAT. Authorized translation by LYDIA GILLINGHAM ROBINSON, B.A., with a Preface by PHILIP E. B. JOURDAIN, M.A. (Cantab.). 1914. Chicago and London: The Open Court Publishing Company. Pp. xiv + 98.

A History of Japanese Mathematics. By DAVID EUGENE SMITH and YOSHIO MIKAMI. Chicago, The Open Court Publishing Company. 1914. Pp. v + 288.

Thousands of readers will be grateful to the author and the publishers for a work that is so beautiful, both physically and spiritually, as the "Memorabilia." The ideal that requires us to dispense entirely with authority and to hold no beliefs and form no judgments not based on evidence examined by ourselves is not attainable. If it were, it would not be an ideal. In the future it will be necessary, as it has been in the past, for all men and women to depend for the most part upon borrowed estimates. Even if it were not, we should still value as such the opinions of others, especially when expressed in worthy and lasting form. In view of such considerations such an undertaking as that of Professor Moritz is amply justified and especially so because this work of his is the first of its kind in the English language. Nor has he, except in the case of "a small number of famous utterances," duplicated Rebiere's "Mathématiques et Mathematiciens" or the "Scherz und Ernst in der Mathematik" of Ahrens. We have here more than a thousand utterances of more than three hundred authors regarding the nature and value of mathematics. The quotations vary in length from a line to several scores of lines, and all of them are in English. In the case of borrowed translations, the translator's name is given. At the end of each passage there are given the author's name and the source of the extract. An attempt to group the material under heads has resulted in dividing the volume into twenty-one chapters. Moreover, the final index refers to nearly seven hundred topics. The list of authors,

which represents all historic times, includes not only mathematicians but students of natural science, poets, philosophers, statesmen, theologians and historians. In respect of fame these range from the obscure to the world-renowned. Various criteria were used for determining the admissibility of passages, as eminence of the author, fitness of content, felicity of expression. Even Shakespeare contributes three passages and Goethe ten. One of these is: "Mathematics, like dialectics, is an organ of the inner higher sense; in its execution it is an art like eloquence. Both alike care nothing for the content, to both nothing is of value but the form." Gauss contributes 10 passages, Poincaré 5, Plato 9, Emerson 2, Euripides 1, Descartes 11, Newton 7, Leibnitz 8, Laplace 13, Daniel Webster 1, Pliny 1, Dante 2, and so on. It is difficult to imagine that any teacher, student or scholar could fail to find instruction and delight in this book of gems.

Professors Snyder and Sisam's book will meet the demand of those who desire a larger knowledge of the analytical geometry of three dimensions than is afforded by the usual first-course books on analytical geometry and who find such works as those of Salmon and Frost too extensive. The first eight chapters present the usual matter but the remaining six chapters of about 180 pages will serve admirably as a basis for an undergraduate advanced elective in the subject; the main topics here treated being tetrahedral coordinates, quadratic surfaces in tetrahedral coordinates, linear systems of quadrics, transformations of space, curves and surfaces in tetrahedral coordinates, and differential geometry of curves and surfaces. There is appended a list of answers to the exercises. Graduate students should come with such preparation as this book yields.

Among the commendable features of Ziwet and Hopkins's book are the treatment of algebraic topics usually presupposed by or studied simultaneously with first lessons on analytical geometry, the early introduction of the use of determinants, the emphasis upon the straight line and the circle as preliminary loci, the attention given to the plotting of polynomials before attacking the conics, and the employment of the notion of the derivative of polynomials. The doctrine of poles and polars is presented only in relation to the circle. The concept of a vector is introduced in connection with applications to mechanics. The elements of the geometry of space occupy 78 pages. Portions that may be omitted are in small type. Answers are given.

Professor Hawkes's book opens with a chapter of 22 pages devoted to a review extending through linear equations in two variables. Functions and their graphs occupy the next chapter (14 pages). Recognizing that a student who would proceed to analytical geometry, the calculus or the theory of higher equations must gain a thorough knowledge of the quadratic equation, the author has devoted a chapter of 27 pages to this important subject. It is handled admirably. A very brief presentation of inequalities is followed by an excellent chapter on complex numbers. There follows a chapter of 75 pages dealing with elements of the theory of the general equation in one unknown. A notable feature is the presentation of Horner's method. The notion of derivative of a polynomial is introduced. Permutations, combinations and probability claim ten pages, followed by the elements of determinant theory. Then follow chapters on partial fractions, logarithms and infinite series. The book closes with some short tables, and a good index. The work is notably successful in its endeavor to make theory and practise reciprocally helpful.

Mr. Marsh's thick volume contains a mass of information designed to enable "industrial" folk to use mathematics without really studying the subject beyond the initial steps. It begins with arithmetic. After much useful direction in a great variety of mensurations, the solution of simple equations is reached on page 354. Mathematical theory is present in only infinitesimal amounts, sometimes of higher order, whilst practise swells toward the infinite. The reader is told how to do things, even how to solve triangles by use of logarithmic tables. The work will help many who are very ignorant of mathematical science. One

of its possible services is that of awakening in the reader a desire to understand the ghostly theory that lurks behind the practician's rules. I shall never forget how unhappy I was made when a boy by having to learn by heart and to use the rule for computing the area of a triangle in terms of its sides before looking into a geometry and what a burden was rolled off when in subsequent years I learned to deduce the rule. Industrial folk will not find it easy to circumvent the necessity of understanding something of the science they would use. The way of the transgressor is hard.

Among the more notable features of Professor Kenyon and Professor Ingold's "Trigonometry" are the prominence given to the solution of triangles, first by geometric methods, then gradually by means of the trigonometric functions and logarithms; the use of composition and resolution of forces to show the significance of large angles and of addition formulæ; the hinging of the treatment on a minimum of theoretical considerations; the very large number and variety of exercises and applications; the omission of DeMoivre's theorem and of infinite series; the presence of a rather extensive chapter on spherical trigonometry, and the inclusion of 124 pages of convenient tables.

The attractiveness of the admirable little volume of Professors Anderegg and Roe is due partly to its smallness. The smallness is due in some measure to conciseness but mainly to omission of tables, model arithmetical solutions, a list of answers and an index. A large part of the book deals with spherical trigonometry. It is shown that plane trigonometry is a special case of spherical. It is evident that the authors are fascinated with the theory of the subject, and their treatment of it looks up toward higher analysis rather than merely down to practical uses and computation.

As we open Professor Collins's "Advanced Algebra" it is pleasant to be greeted by a genial likeness of Sylvester and, as we pass on, to encounter the pictures of Tartaglia, Cauchy and Gauss, with brief accounts of them. A first-year course is presupposed. The book falls into three parts, devoted respectively to a review, to the remaining topics of elementary algebra, and to such college topics as general equation theory, probability, determinants and infinite series. The author's aim has been to equip the student to meet either of the two algebra standards of the College Entrance Board and to carry him well into college topics.

Many students of modern logic will welcome Miss Robinson's excellent English translation of Dr. Couturat's well-known "L'Algèbre de la logique." This edition is distinctly enhanced by the preface prepared by Mr. Jourdain. Here and now are not the place and time to review the content of a work of which the original French edition was published in 1905. Suffice it to say that it consists of the elements of the classic logic of exclusion and inclusion presented in algebraic garb and that the algebra of logic is not to be confounded with what is known as the logic of mathematics.

From the mathematical public thanks are due Professor Smith, Mr. Mikami and the Open Court Publishing Company for their "History of Japanese Mathematics." Owing to the wellnigh complete insulation of the Japanese until recently from the western world, this first English account of their mathematical work is a real romance in the austere things of the human spirit—almost as fascinating as would be a message from Mars. We confess to having read every line of it with eager and increasing interest. Not only will all liberal students and teachers of mathematics wish to read it but it is rich in material for psychologists, historians and other scientific students. In particular may anthropologists find in it evidence both for and against the thesis that similarity or dissimilarity of circumstances determines similarity or dissimilarity of intellectual developments. Even if space allowed it would be a kind of injustice to delineate the content of this volume here and so deprive the reader of it of the pleasure of meeting its surprises first-hand. Suffice it to say that the numerous beautiful photographic illustrations (made by Mr. L. L. Lock)

are themselves well worth the price of the volume.

Cassius J. Keyser

A Dictionary of Applied Chemistry. By Sir Edward Thorpe. Longmans, Green & Company. 5 vols., 800 pp. each. Price $13.50.

Samuel Johnson, to use his words, "noting whatever might be of use to ascertain or illustrate any word or phrase, accumulated in time the materials of a dictionary." A proper dictionary of chemistry might then well be a collection of whatever information might be of use in ascertaining and illustrating words and phrases of chemical usage. Some such broad foundation was used in the dictionary at hand.

Thorpe's "Dictionary of Applied Chemistry," first published in 1890, has ever since been such a well-known dictionary that a review of this new and enlarged edition need concern only the completeness of the accumulations since then. It is clear that no other English work contains so much information of chemical nature. As it also gives the main references to literature on many subjects, it is difficult to conceive of any improvement which the chemist might fairly expect. There are now five volumes, as against three in 1898. Emerson's reference to dictionaries, in his essay on Books, is particularly fitting when shorn of any points of irony: "Neither is a dictionary a bad book to read. There is no cant in it, no excess of explanation, and it is full of suggestions—the raw material of possible poems and histories." This has all seemed very pertinent to me in reading the "illustrations" of some of the chemical words. "Absorption spectra and chemical composition" has charm and rhythm that must be poetry to every real chemist. The brief accounts of such perennially youthful patriarchs as iron, tungsten, boron, etc., are free from "cant" and "excess," and are powerful new history. The Frash process, by which practically all the sulphur in the United States is now produced, is a very interesting story and particularly to those who know only of the Sicilian sulphur of the older books.

Hardly a single chemical element has been "dead" since the publication of the first edition of this Dictionary, and therefore they all had their history rewritten. Then almost no hydrogen was technically applied, no oxygen manufactured, no aluminum sold. Silicon, tantalum, argon and radium were all practically unheard of.

A great deal had to be written to "illustrate" the words of modern applied chemistry, novelties of the recent period: cryoscopy, cyanamid, monel metal, metallography, etc. This has been well done, and usually by experts. Who, for example, could better describe carbon bisulphide than our own E. R. Taylor, who makes about all that is used in America? The oils, fats, waxes, etc., have been cared for by Lewkowitsch, water by Frankland, potash by Lunge, radioactivity by Bragg, cellulose by Cross, and paper by Bevan, dyes by Perkin, and acetylene by Lewes. Thus scores of the most prominent chemists of all nations have aided the work.

A few more of the indicators used to determine that the work has been brought up to date may well be mentioned. The ancient and interesting "suffoni" are now partly displaced by California mines of colemanite as a source of boric acid. Cement is now burned in rotating kilns of 150 feet length. Oxyhydrogen and oxyacetylene metal cutting are well described. Chemical affinity, equilibria and catalysis are living subjects evidently still being studied at the time of going to press, and they are made comprehensive by articles of breadth. Bordet's and Ehrlich's different views of the interaction of toxins and antitoxins are disclosed. The Claude and the Linde air liquefaction processes and the liquefaction work on hydrogen and helium by Travers and Olszewski are fully described. Four different uses of the word ferrite are described, which ought to militate a little against the use of this word for any other newly discovered material.

Chemical analysis is treated in 100 pages as compared with 57 of the 1898 edition: Azo colors in 38 pages, as against 28; carbohydrates, 24 as against 4; naphthalene, 102, in place of 65; ozone 8 against $2\frac{1}{2}$; rust and corrosion of iron 11 against $2\frac{1}{2}$; spectrum analysis 30

against 20. The additional space devoted to such subjects is usually distributed well. One or two subjects might still be extended. For example, iron (including all steels) is covered in twenty pages, one fifth that devoted to naphthalene. No mention of electric furnace steel products is made. Such subjects as metallography (21 pp.), toxins and antitoxins (4), colloids (4), utilization of atmospheric nitrogen (12), radioactivity (11), and many others appear for the first time. These representatives will also serve to indicate that the dictionary is not so closely confined to applied chemistry as the earlier editions. In many of the topics the completeness is quite remarkable and frequently includes references to patents containing matter not found in other published researches, and therefore not generally available.

W. R. WHITNEY

Catalogue of Scientific Papers. Fourth Series (1884–1900). Compiled by the Royal Society of London. Vol. XIII., A–B. Cambridge, University Press. 1914.

The first incentive to the monumental undertaking of which the present volume marks the beginning of the end in its original form, came from America, in a communication from Professor Joseph Henry to the British Association at Glasgow in 1855, suggesting the formation of a catalogue of philosophical memoirs, which was favorably reported upon by a committee of the Association in the following year. Six volumes, in quarto, covering the scientific periodical literature from 1800 to 1863, were issued under the superintendence of the Royal Society from 1867–72, and were followed by two volumes, covering 1864–73, in 1877–9, three volumes, covering 1874–83, in 1891–6, and a supplementary volume, covering literature of 1800–83 not hitherto indexed, in 1902. The present volume is the beginning of a series which will cover all papers published or read during 1884–1900, completing the catalogue for the whole of the nineteenth century. The four series, when completed, will thus comprise a complete author catalogue of the scientific literature of 1800–1900, no subject rubrics being employed. All scientific literature published after the end of 1900 has been in the hands of the authorities of the International Catalogue of Scientific Literature, and since 1907 has been issued in the form of subject bibliographies of the fundamental sciences by the International Council of the Royal Society.

Before the Royal Society undertook this work, there had been, from the time of Conrad Gesner's "Bibliotheca Universalis" (1545–49), other bibliographies of similar scope, such as the "Repertorium commentationum" of J. D. Reuss (1800–21), which was confined to society transactions and not limited to scientific papers, or the "Gelehrten-Lexicon" of C. G. Jöcher (1750–51), continued by Adelung and Rotermund (1784–1819), with a final volume by Rotermund (1897). In the year of the Royal Society's first venture in this field (1865), the physicist, J. C. Poggendorff (of Poggendorff's *Annalen*) published his "Biographisch-literarisches Handwörterbuch," containing biographical bibliographies of 8,400 scientists, which was continued for the years 1858–83 by Feddersen and von Oettingen in 1898, and to 1904 by the latter. Of exhaustive bibliographies of special subjects, many of which are listed in Petzholdt's "Bibliotheca Bibliographica" (1866), there have been such striking examples as those of Haller in botany (1771–2), anatomy (1774–7), surgery (1774–7) and internal medicine (1776–8); A. G. Kästner in mathematics (1796–1800); C. P. Callisen's 33-volume catalogue on the medical literature of his time (1830–45); L. Agassiz in zoology and geology (1848–54), and such later works as those of Waring in therapeutics (1878), R. Schmid in public hygiene (1898–1906), Laehr in neurology (1900), Stiles and Hassall in parasitology (1900–2), and Abderhalden in alcoholism (1904). The entire literature of medicine has been covered, both for authors and subjects, in the well-known "Index Catalogue" of J. S. Billings (1880–1914), now nearing its completion. The author catalogue of the Royal Society forms at once a supplement and a complement to all these, containing many titles not to be

found anywhere else. The immense proliferation of scientific literature in seventeen years alone (1884–1900) may be judged by the fact that the present volumes, of 951 double-column pages in small type, covers only letters A–B. This is due to the fact that, in addition to periodicals and serials devoted to pure science, many publications of lighter weight have been indexed, as containing occasional contributions of value. The list of new abbreviations covers some 90 pages. In this we find such titles as *L'Abeille* (entomology), the *Analyst* (chemistry), *Aquila* (ornithology), the *Electrician, Garden and Forest,* the *Humming Bird,* the *Sidereal Messenger,* the *Wombat,* the *Journal of Tropical Medicine,* the *New York Medical Journal* and the *Practitioner.* Such titles do not, however, connote triviality, but the editors admit that the selection of material in the less exactly defined sciences, such as anthropology or geography, can not be made from a rigid viewpoint. Not presuming to go outside the medical sciences, a number of titles might be noted which are nowise reports of original work, but *articles d'actualité,* abstracts or *résumés* of work done by others, a species of ephemeral literature in which medicine, more than any other group of sciences, abounds. Any one familiar with medical bibliography will realize how unavoidable such inclusions are; but in the more rigorous branches of science there is little chance for vulgarization, and "abstracts" are usually described as such. One very valuable feature of this catalogue consists in the well-selected obituaries and memorial notices of deceased individuals, for instance those of the surgeon Billroth (p. 558) or the physiologist Brown-Séquard (p. 851). The system of Russian transliteration adopted is a new departure. In the twelve volumes preceding, the standard used was a table, approved by Löwinson-Lessing, Morfill and other Russian scholars, and adopted by the British Museum, the Royal Society and other learned bodies in England.[1] The present system, which is also employed in the "International Catalogue of Scientific Literature," is based on the phonetic value of Roman letters in Bohemian. Thus what was formerly written *zh* becomes *ž*, *kh* becomes *ch*, *ch* becomes *č*, *sh* becomes *š*, and *shch* becomes *šč*, *ya* or *yu* becomes *ja* or *ju* at the beginning of a syllable and *ia* or *iu* after a syllabic consonant. These improvements will undoubtedly make for less unsightly names or words in print, and, if standardized, may mercifully settle the vexed question of Russian transliteration. In the present catalogue, however, it has been necessary to employ cross references to facilitate identification with names in earlier volumes transliterated after the old method. One of the great difficulties in cataloguing Russian names is the fact that German or other non-Russian names in Russian text are often violently wrenched from their true orthography, making strange appearances when rendered by certain transliterators. Thus *Wales* becomes *Uels*, *Herzen* becomes *Gertsen*, *Zoege-Manteuffel* becomes *Tsege-Mantaiffel* and *Poehl* is written *Pel.* The difficulty is further complicated by the fact that many Russian writers of Yiddish extraction who bear German names decline to spell such names German fashion, when written in Roman characters, adhering to a servile transliteration of the Russian. This is very commonly seen in the students' dissertations of Berne and Zürich, where Jewish pupils abound. Even before the days of Yuryev and Petrograd, it was necessary for the bibliographer to have a certain *flair,* an actual *science des noms* in Russian transliteration. In regard to another detail of the science of personal names, the Royal Society Catalogue has preserved throughout an admirable consistency and uniformity. Thus the prefixes *d', Da, Dal, de, De, Del, Della, van, Van, von* are all lower-cased and not considered as part of the name, Da Costa appearing under Costa, and the Belgian Van Beneden along with the Dutch van Beet or the German von Bardeleben. Names preceded by *Du, Des, Mac* and *O'* are, however, found under the letters *D, M* and *O,* and those preceded by *La, Le, Les* are all found under the letter *L.* In English and Dutch compound names, the last name is preferred; in French, Spanish

[1] *Nature,* 1889–90, XLI., 396–97.

and Portuguese, the first. Any system of this kind, if rigidly adhered to, is of vast aid in cataloguing. How to catalogue such a name as "du Bois Reymond" is one of the ever-recurring puzzles of bibliography. In listing abbreviations, the Royal Society Committee still adheres, in many instances, to the practise of placing the locality of a given society at the head of the abbreviation of the title of its transactions, instead of after it, as ordinarily, which sometimes loses it under an unknown entry. In some cases, this difficulty is obviated by a cross reference, but the custom can not be commended. A few very trifling errors have been noted, such as the confusion of J. S. Billings, Sr. and Jr., but these are surprisingly rare in a work of such vast extent. The impeccable typography is in itself a token of accuracy in indexing. The entire series, when completed, will be one of those invaluable works which no scientific library can do without for any length of time.

F. H. Garrison, M.D.

Army Medical Museum

THE NATIONAL CONFERENCE COMMITTEE

The seventh conference of the National Conference Committee on Standards of Colleges and Secondary Schools was held at the rooms of the Carnegie Foundation for the Advancement of Teaching, New York, on February 28.

The following delegates were present as representatives of the organizations indicated:

Headmaster Wilson Farrand, Newark Academy, representing the College Entrance Examination Board, *President*.

Dean Frederick C. Ferry, Williams College, representing the New England Association of Colleges and Preparatory Schools, *Secretary-Treasurer*.

Professor Frank W. Nicolson, Wesleyan University, representing the New England College Entrance Certificate Board.

Dean Frederick P. Keppel, Columbia University, representing the Association of Colleges and Preparatory Schools of the Middle States and Maryland.

Principal Frederick L. Bliss, Detroit University School, representing the North Central Association of Colleges and Secondary Schools.

Chancellor James H. Kirkland, Vanderbilt University, representing the Association of Colleges and Secondary Schools of the Southern States.

President John G. Bowman, The State University of Iowa, representing the National Association of State Universities.

Secretary Clyde Furst, as substitute for President Henry S. Pritchett, representing the Carnegie Foundation for the Advancement of Teaching.

Honorable Philander P. Claxton, the United States Commissioner of Education.

There was present also, by invitation, as a visitor, Dr. Samuel P. Capen, specialist in higher education in the National Bureau of Education.

Headmaster Wilson Farrand, president of the committee, presided at both the morning and the afternoon sessions.

The subcommittee, consisting of Headmaster Farrand (chairman), Dean Ferry, President Pritchett and Principal Bliss, gave a report of an investigation made by its chairman to ascertain the number of recitation periods per week devoted to Mathematics A, History A, History B, History C, History D and Civics (as a separate study), the year in the course when each of these subjects is taken by the pupil, and the number of periods per week which constitute the normal schedule of the pupils in the schools considered. Information had been procured from 363 schools widely scattered through the country. The results seemed to the committee to warrant the raising of the question of increasing the weight (in units) given to Mathematics A and decreasing the weight given to each of the four history subjects.

The subcommittee suggested also the consideration of the proposal presented from various sources, and particularly from the North Central Association of Colleges and Secondary Schools, that there be a discrimination among units according to the time in the secondary school curriculum when the subject is studied; *e. g.*, units of the first two years might be called "minor" units, those of the last two years "major" units, and perhaps those of the second and third years "intermediate" units. A third suggestion was to

the effect that it might be advantageous for colleges and universities to demand that a certain number of admission units, say ten or twelve, be confined to a small number of subjects, say three or four, and that only a definite minimum be made up of isolated subjects. After much discussion, it was voted without dissent that these questions be referred to the constituent bodies for consideration and advice; and for that purpose the following circular letter was later prepared by Dean Keppel and Secretary Furst for submission to the members of the organizations whose delegates constitute the National Conference Committee on Standards of Colleges and Secondary Schools:

In spite of the marked progress toward uniformity in college entrance credits, this committee is informed of certain recurring difficulties in administration. It appears, for example, from our general inquiry concerning the subject, that elementary algebra is usually given more time than is represented by the unit and a half of credit given to this subject, and that certain branches of history are usually given less time than is represented by the unit of credit that they receive. There is, on the other hand, a tendency toward a strictly mechanical interpretation of the unit, even to the point of counting minutes, which emphasizes the letter rather than the spirit of a system of merely approximate measures.

The committee realizes the importance of recommending as few changes in the regulations as possible, but it believes that it will be of service if the organizations that it represents will consider and report to the committee their official judgment or the attitude of their members toward the following suggestions:

A. That the unit credits assigned to the subjects of elementary algebra and history be modified so as to represent more nearly the amount of time given to these subjects.

B. That in certain subjects—as for example, history—the amount of credit to be assigned should not be uniform in all cases but should vary with the time and attention given.

C. That some distinction be made between the amount of credit that is given to subjects taken in the early years of the high school and those taken in the later years.

D. That there be adopted some uniform plan of limiting the number of subjects in which credit may be gained in order that continuity of work may be secured in at least two subjects.

The committee having received many requests for a uniform blank for the submission to the college of a statement of the school record, and it being understood that committees of the Association of Colleges and Preparatory Schools and of the College and University Presidents Association of Pennsylvania are already engaged in the preparation of such a paper, it was voted that the subcommittee seek information on this subject, consult with other committees, and report to the committee at its next meeting.

Commissioner Claxton asked that the National Conference Committee undertake the task of defining many terms which have come into use in modern education, school administration, etc., and have not had certain and clear meanings assigned to them. It was agreed that the committee should undertake this work with the expectation that some part of it, at least, could be successfully accomplished. It was accordingly voted that the subcommittee be instructed to take this subject under consideration with a view to the extension of the field of the committee to the desired determination of definitions and that a report be made at the next meeting.

Officers for the ensuing year were elected as follows:

President, Headmaster Wilson Farrand.
Vice-president, Chancellor James H. Kirkland.
Secretary-treasurer, Dean Frederick C. Ferry.

The choice of the subcommittee was left to the president with the provision that he serve as its chairman. The other members, as appointed by him, are Chancellor Kirkland, Dean Ferry and Dean Keppel.

Frederick C. Ferry,
Secretary

SPECIAL ARTICLES

THE "MULTIPLE UNIT" SYSTEM AS A SOURCE OF ELECTRICITY FOR LABORATORIES [1]

The problem of furnishing electricity, adapted to physiologic and pharmacologic ex-

[1] From the pharmacology laboratory of the Northwestern University Medical School.

perimental work, has been satisfactorily solved in but few laboratories. Very little on the subject is found in the literature and the need of a practical method which is comprehensive and can be intelligently adopted, is becoming apparent. With this in mind the writer presents a brief discussion of the sources of electricity suitable to laboratory use, with special reference to what he terms the "multiple unit" system.

Dry batteries are extensively used chiefly because of their compactness, ease in handling and apparent cheapness. But they are not dependable, since they polarize easily, the current is not constant and the supply is limited. Because of this much time is often lost in getting apparatus to work properly. In addition the cost per year is usually a considerable item. Yet in spite of these inconveniences they still remain the common source of electrical supply. Wet batteries have the same disadvantages as dry cells. They are also clumsy and hence little used. Storage cells are fairly reliable but their bulkiness and expense make them undesirable for student work.

The direct electric lighting current is an excellent source. A suitable resistance wire is attached in series to this as a rheocord from which sufficient current may be tapped off at various points and led to different instruments. The principle involved is well known, although it appears that but few physiologic or pharmacologic laboratories are utilizing it. This shunt rheocord system has the advantage of being absolutely reliable. The current is of unlimited supply and the voltage or amperage can be either made constant or varied at will. This is important in the stimulation of tissues with the direct current, where graded amounts are desired. Such an outfit may be made compact, accessible and inexpensive; it requires little care and will last indefinitely.

The installation of such a system involves several important considerations.

First, Source.—Preferably, a direct 110-volt current should be used.

Second, Amperage Carried.—This is determined largely by (*a*) the amount of current necessary to make any instrument work properly, (*b*) the internal resistance of each, and (*c*) the number of instruments to be used and their effect upon the line amperage when shunted into the line resistance. Most inductoria of American make operate best with a current of .5 to 1 ampere and 1.5 to 2 volts. The Harvard coil has an internal resistance of about .5 ohm, but this may rise as high as 1 ohm with the interrupter in series if the contact points of the latter are poor. The Stoelting make No. 7090 has 1.5 ohms, and 2 ohms or more with the interrupter. Signal magnets all work well with 1.5 to 2 volts and .5 to 1.5 amperes. Their resistance ranges between .5 ohm and 3 or more ohms (Stoelting No. 7076—.5 ohm; Harvard—3 ohms). An induction coil in series with a magnet requires a 2 to 3 volt and a .4 to 1 ampere current. An average resistance of all the instruments is about 1.5 ohms. Practically, the above amperages may be decreased within certain limits if the voltages are correspondingly increased, and vice versa. Individual needs will determine the number of instruments to be used. In this laboratory accommodations are provided for sections of thirty-five students each, and a maximum of sixty-five instruments is permitted.

Great increases in the line current must be avoided, and in order to determine the current necessary to keep this rise in the line amperage below any desired maximum, say 15 per cent., it is of advantage to keep in mind the following formulæ:

The current in amperes (i) equals the potential in volts (e) divided by the resistance in ohms (r).

$$i = \frac{e}{r} \quad \text{or} \quad e = ir \qquad (1)$$

The conductance of two wires in parallel equals the sum of the two separate conductances, conductance being the inverse of resistance.

$$\frac{1}{r} = \frac{1}{r'} + \frac{1}{r''} \quad \text{or} \quad r \frac{r'r''}{r' + r''} \qquad (2)$$

The amount of current passing through each of two wires in parallel is inversely proportional to its resistance.

$$i' : i'' = r'' : r' \qquad (3)$$

The amount of current passing through two wires in parallel equals the sum of the two separate currents.

$$i = i' + i''. \qquad (4)$$

As an illustration, a rheocord, taking 2 amperes from a 110-volt main, has a resistance of 55 ohms (formula 1) and 2 volts drop for each ohm. Shunt in a 1.5 ohm signal magnet on this line at two points, *A* and *B*, between which there are 2 ohms and consequently 4 volts. The intervening resistance becomes by formula (2) .85 ohm and is therefore reduced 1.15 ohms. The total line then has a resistance of 53.85 ohms and a current of 2.04 amperes (formula 1). Between *A* and *B* the voltage becomes $2.04 \times .85$ or 1.75 (formula 1) and the solving of equations from formulæ (3) and (4) shows the line amperage so divided that .85 ampere passes through the line and 1.15 amperes pass through the instrument. Accordingly, the magnet receives a current of 1.75 volts and 1.15 amperes, which is sufficient. But, should twelve such instruments be connected to similar sections of the line, the resistance would be reduced 1.15 ohms for each section and 13.8 ohms for the twelve sections giving the line a resistance of only 41.2 ohms and a current increased to almost 3 amperes (formula 1). The point is that the shunting in of too many instruments on a 2 ampere system would raise the amperage beyond the safe carrying capacity of the wire. The danger in this case is eliminated by using 3 or 4 instruments only, which can be operated across 8 or 10 ohms of resistance. Thus two parallel 32-candle-power lamps connected in series with 10 ohms of wire will furnish about 2 amperes and will operate instrument circuits of 1.5 or more ohms. Several such systems are required for large classes and the total amperage supply is necessarily high.

Figuring with greater amperages on a single line, it is found that an 11-ampere line will accommodate sixty-five instruments on separate shunts and keep the rise in amperage below 15 per cent. This is easily determined: on a 10-ohm line carrying 11 amperes, let there be between two points *A* and *B* a potential of 2 volts and a resistance of .18 ohm, each ohm having a drop of 11 volts. With a 1.5 ohm instrument shunted in, there is found a resistance of .16 ohm (differing by .02 ohm from the original .18 ohm), a potential of 1.76 volts, and a current through the instrument of 1.2 amperes. Sixty-five instruments averaging 1.5 ohms each, even when shunted in simultaneously on separate sections, give a total reduction of 1.3 ohms, and leaving 8.7 ohms in the line allow the passage of 12.6-ampere current, which is an increase of 15 per cent. above the normal. But, as less than twenty machines ordinarily are operating at any instant, there can be a resistance not reduced more than .4 ohm, a current not greater than 11.5 amperes and hence an amperage rise not over 5 per cent.

Third, Resistor Used.—Most of the electricity passing through a line is transformed into heat energy and the temperature of the conductor rises until the heat generated by the current equals the heat dispersed per unit of time. This heat rise, other things being equal, varies to a large degree inversely with the amount of radiating surface, which again is determined by the size, length and resistivity of the wire as well as its actual resistance. A large heat rise reduces the radiating surface necessary, and for a short wire a high resistivity must be used. For a moderate heat rise as 150° F. the radiating surface becomes proportionately larger and a correspondingly moderate resistivity is demanded on a short line carrying 5 or more amperes. Comparative resistances of resistors range between 1 and 65 times that of copper. For a 2 ampere system ordinary carbon lamps and any wire of high resistance as B. & S. No. 18 "Nichrome" is satisfactory. In the "Multiple Unit" system, which, carrying 11 amperes, has 10 ohms of resistance and is allowed an arbitrary heat rise of 160° F., the resistivity for a line made as short as possible for compactness is found to be about twenty times that of copper. As an example No. 15 B. & S. 18 per cent. German silver wire 19 times as

resistant as copper and carrying 11 amperes will give a heat rise of about 160° F. The length is less than 200 feet. In selecting wire for conditions other than those given above, the different wire capacity tables may be consulted for various heat rises, lengths, etc., that are easily obtained from wire manufacturers. The choice will lie mainly with iron, 18 per cent. and 28 per cent. German silver, "climax" and nickel-chromium wires or their equivalents given under various trade names. Their resistances are, respectively, seven, twenty, thirty, fifty and sixty times that of copper.

Fourth, Unit System Installed.—The "individual unit" system, as previously mentioned, carrying 2 amperes, is applicable for a limited number of certain instruments, particularly those of higher resistance. Several such systems are necessary for class work. Jackson's[2] "single unit" system consists essentially of one large frame over which is strung the resistance line, and has a capacity for a large number of instruments. This has in general all the favorable points of the shunt rheocord system, but the chief drawback is that such a frame is situated at one place from which all tapping wires must lead. In class work this may incur confusion in identifying individual tappings, and more especially necessitates the running of an excessive amount of wire from the frame to each table. Further, it is desirable that each machine, particularly inductoria, has its own separate connection to the resistance board in order that its operating current may be varied at will and may not be affected by the working of any other instrument, as is the case when one or more are placed in parallel with it. The "multiple unit" system eliminates this objection to the "single unit" by dividing the latter into several sectional units connected in series and placing one section near each table. Confusion is avoided, extensive wiring unnecessary, and quick variations of currents to individual instruments readily made.

Fifth, Miscellaneous Details.—In general, these are for convenience and safety and concerned with electrical rules and regulations. The main leads and the wires connecting the sectional units should be insulated copper large enough to carry the desired current (B. & S. No. 16—6 amperes, No. 14—12 amperes and No. 12—15 amperes). All connections are thoroughly fastened or spliced and soldered if necessary.

Sectional or individual units may be constructed to suit individual preferences, the only requirement being proper insulation of the bare wire. Stringing the resistance line over wooden frames, even asbestos lined, is not always advisable because of possible dangers from accidental overheating. Slabs of slate or stone are more preferable since they permit ample insulation and protection. The resistant units in the author's "multiple unit" system are slate slabs 14 in. x 12 in. x 1 in. in size with a ¼-in. beveled edge, a ¼-in. hole near each corner for fastening unit to the wall being separated from it by 2-in. porcelain spools. One inch in along each long side a row of holes is drilled to fit 3/16 in. stove bolts, the holes being ¾ in. apart and so located that the wire when strung shall run in a zigzag manner. Through the holes bolts are inserted from the rear surface; a washer is placed on each next to the slate on the front surface; and the wire is strung tightly from bolt to bolt, each of which is finally tightened by a single washer and nut. The bolt ends should project out free ½ in. so that spring clips of the tapping wires may be easily attached where direct wire tapping is less convenient or not desired. Wire strands between bolts are 10 in. long and each strand produces approximately a .5-volt drop in the current. Thus a 2-volt drop is obtained across four strands. If tappings are to be made from the bolt ends only, the resistance wire may be coiled spirally, thus shortening the span of the strands and materially diminishing the size of the units.

Tapping wires are twisted flexible lamp cord of ten or other convenient length with ends numbered and all lightly soldered to prevent the strands from breaking and with spring clips, fastened to one pair of ends, for attaching to the bolt ends or the resistance wire.

[2] Jackson, *Journal A. M. A.*, 1912, Vol. LVIII, p. 1011.

Into the tapping wires between the spring clips and instrument connections ½ or 1 ampere fuses, which "blow out" with 1½ to 2½ amperes of current, may be inserted. Provision is made for connecting in series one or, in some tapping sets, two instruments.

The system may be briefly described as follows: The "multiple unit" system, used in the pharmacology laboratory of the Northwestern University Medical School consists of 8 sectional units, connected in series, strung with 10 ohms of No. 15 B. & S. German silver 18 per cent. nickel alloy wire about 200 feet long. The 110-volt, 11-ampere current enters at the positive main, passes through a cartridge fuse and switch on an enclosed switchboard, to resistance unit No. 1, to unit No. 2, so on consecutively to unit No. 8, and back through the switch and a fuse to the negative main. A pilot light is connected in parallel across some unit to indicate when current passes through the line. From varying points on any unit, double-fused flexible lamp cord may be led off to an inductorium. Similarly, a signal magnet, or an inductorium with a signal magnet in series, may be connected. Each strand is 10 in. long and has a .5-volt potential. Single instruments operate across a 3 or 4 strand shunt (1.5 to 2 volts), two instruments in series operate across a 4 to 6 strand shunt (2 to 3 volts). All instrument circuits take .5 to 1.5 amperes, according to their resistance, while during the passage of the current the voltage drops from .05 to .3 volt, due to the decreased resistance across the shunt. It is wise to test each instrument, because of possible differences in its resistance, with the volt-meter and the ammeter before using it in regular work. The "multiple unit" system is likewise admirably adapted not only for tissue stimulation with the direct current as previously mentioned, but also for physiologic chemical work as the determination of copper in sugar analysis, etc. The cost of such an outfit will range between 5 and 15 dollars, including units, switch box, wire and tapping cords. Since the operating expense is but a few cents per hour and the "system" is a permanent fixture, the actual expense is much less than that of dry batteries, which must be frequently renewed.

A few possible dangers are to be remembered. If the negative main be connected to the ground, as occurs with some power plants, "grounding" of the positive main from any point along the resistance line may take place through a tapping wire, either directly by contact with water pipes, radiators, etc., or indirectly through instruments not insulated from stands which themselves are grounded. In either case the grounding wire and any instrument in series with it takes part of the line current which usually burns out the small fuses in the tapping wire but, if not, may be so large as to injure the instrument. Signal magnets, if not insulated, may "short circuit" by permitting the current to flow from one instrument to another, either through a common stand rod, or through metal writing levers touching a kymograph drum not covered with tracing paper. This will prevent the passage of sufficient current through the instruments which then do not work properly. With a 2-ampere system for 3 to 4 instrument capacity, only the last 8 or 10 ohms of the wire nearest the negative main should be used. This, as well as the fusing of the individual tapping wires, minimizes the danger. Likewise, it is preferable if possible to have instruments operated on the negative side of a larger ampere line in order to reduce the seriousness of grounding. Students should be given the following instructions to prevent these occurrences.

First, *always* make sure that the line has no possible "ground" before the main current is switched on.

Second, tap *last* from a resistance unit when setting up an apparatus and disconnect *first* from the unit when changing instruments or through using apparatus.

Third, *insulate* signal magnets and other electrical apparatus from metal stands by heavy rubber tubing and keep tracing paper on drums which are in contact with metal writing levers.

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